A General Overview of Benthic Ecological or Biological Significant Areas (EBSAs) in Maritimes Region

E. Kenchington

Department of Fisheries & Oceans,
Maritimes Region,
Oceans and Ecosystem Sciences Division,
Bedford Institute of Oceanography,
PO Box 1006, Dartmouth,
Nova Scotia B2Y 4A2
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Compiled by

E. Kenchington

Department of Fisheries & Oceans,
Maritimes Region,
Oceans and Ecosystem Sciences Division,
Bedford Institute of Oceanography,
PO Box 1006,
Dartmouth, Nova Scotia B2Y 4A2
CANADA

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ABSTRACT

Kenchington, E. 2014. A General Overview of Benthic Ecological or Biological Significant Areas (EBSAs) in Maritimes Region. Can. Tech. Rep. Fish. Aquat. Sci. 3072: iv+45p.

Information on benthic ecologically or biologically significant areas (EBSAs) formed by marine benthic species in the Maritimes Region of DFO was compiled from the literature. Fourteen biogenic habitats that are considered to be structure-forming and serving to locally increase species richness and/or contribute significantly to ecosystem function (e.g., high productivity, provision of food, refugia from predation and/or the environment) are ranked against DFO and CBD EBSA criteria. Additionally 4 species groups with key bioturbating function and 4 benthic physical features which may be proxies for EBSAs are listed. For each a photo, general description of the habitat and primary ecological or biological significance are provided along with a non-exhaustive list of the same or similar habitats in other jurisdictions and sources of further information. This inventory in non-exhaustive and and is not meant to be an exclusive listing.

RÉSUMÉ

Kenchington, E. 2014. Une vue d'ensemble des zones d'importance écologique et biologique (ZIEB) benthiques dans la région des Maritimes. Can. Tech. Rep. Fish. Aquat. Sci. 3072: iv+45p.

Les renseignements sur les zones d'importance écologique et biologique (ZIEB) benthiques formées par les espèces benthiques marines dans la région des Maritimes ont été compilés à partir de documents. Quatorze habitats biogéniques considérés comme structurants et favorisant l'accroissement de la richesse des espèces à l'échelle locale et contribuant grandement à la fonction écosystémique (p. ex. productivité élevée, fourniture de nourriture, refuge à l'abri de la prédation et de l'environnement) sont classés en fonction des critères des ZIEB du MPO et de la CBD. En outre, quatre groupes d'espèces jouant un rôle clé dans la bioturbation et quatre caractéristiques physiques benthiques pouvant servir d'indicateurs pour les ZIEB sont énumérés. Pour chacun, une photo et une description générale de l'habitat et de l'importance sur le plan écologique ou biologique sont fournies, et elles sont accompagnées d'une liste non exhaustive des habitats identiques ou similaires dans d'autres provinces et territoires et de sources de renseignements complémentaires. Ce répertoire n'est pas exhaustif et ne constitue pas une liste exhaustive.

1 INTRODUCTION

The Convention on Biological Diversity (CBD) criteria, established in 2008 (Decision IX/20), for identifying Ecologically or Biologically Significant Areas (EBSAs) in need of protection (Annex I) are:

1. Uniqueness or rarity,
2. Special importance for life history of species,
3. Importance for threatened, endangered or declining species and/or habitats,
4. Vulnerability, fragility, sensitivity, and slow recovery,
5. Biological productivity,
6. Biological diversity, and
7. Naturalness.

Canadian guidelines for the identification of EBSAs in Canadian waters are different but similar to the CBD EBSA criteria, the process having been established prior to the CBD deliberations (DFO 2004). Identification of EBSAs in Canada is made using three criteria:

1. Uniqueness/Rarity,
2. Aggregation, and
3. Fitness Consequences

while Naturalness and Resilience qualities are used to prioritize amongst sites. EBSAs have been identified in some of the Canadian large ocean management areas and "lessons learned" from their application were recently reviewed (DFO 2011).

Canada's 1997 Oceans Act authorizes the Department of Fisheries and Oceans (DFO) to provide enhanced protection to areas of the oceans and coasts which are ecologically or biologically significant (DFO 2004). It has been established that "Ocean areas can be ecologically or biologically "significant" because of the functions that they serve in the ecosystem and/or because of structural properties. Although structure and function are inter-dependent, an area can be "significant" for either reason" (DFO 2004).

This document provides a general overview of 14 benthic biogenic habitats that are considered to be structure-forming and serving to locally increase species richness and/or contribute significantly to ecosystem function (e.g., high productivity, provision of food, refugia from predation and/or the environment). Biogenic habitats are defined as habitats created by one or more abundant species or of their remains (both plants and animals create biogenic habitats). The scale of biogenic habitat can range from cm-sized patches to kilometer wide areas. Here the focus is on species which form large-scale habitat features (10s of meters to 10s of kilometers).

Of the many ecosystem functions that benthic species fulfil, in addition to providing structure, this document considers only bioturbation as a key activity as it captures a different group of organisms from other important activities, such as filter feeding. Bioturbation has been demonstrated to have profound effect on benthic community

structure. As for the structure-forming habitats a general overview of 4 species groups which perform this important function is provided.

Lastly, it is recognized by both DFO and the CBD that often there is insufficient knowledge to evaluate an area based on species composition. In such cases physical features can be used to infer EBSAs. This practice has been followed for the delineation of vulnerable marine ecosystems (VME) in the high seas, where VME elements such as seamounts, canyons etc. serve as a proxy for the likely presence of VMEs (FAO 2009). This document considers 4 physical benthic features which may be EBSAs under the "Strong Topography" feature discussed by DFO (2004).

As noted by DFO (2004, 2011) species contribute to ecosystem function in many ways. When preparing this list of 18 species groups, each was assigned according to the structure or function for which there was either more evidence for or the scale of which was larger. For this reason, the xenophyophore fields were considered under their bioturbation function as their influence as creators of structure-forming habitat was associated with the size of individual tests rather than whole assemblages.

This list *is not meant to be exhaustive*. Rather it identifies in one place the *key* benthic habitats found in the Maritimes Region of DFO. Both coastal and offshore habitats were considered. For each habitat, a photo, general description of the habitat and primary ecological or biological significance are provided along with a non-exhaustive list of the same or similar habitats in other jurisdictions. For these latter, European listings were primarily considered: the OSPAR Commission list of threatened and/or declining species and habitats in the North-East Atlantic (http://www.ospar.org), the European Commission Habitats Directive Annexes (Annexes I and II to the Directive contain the types of habitats and species whose conservation requires the designation of special areas of conservation. Some of them are defined as "priority" habitats or species. Annex IV lists animal and plant species in need of particularly strict protection) (http://europa.eu/legislation_summaries/environment/nature_and_biodiversity), the United Kingdom Biodiversity Action Plan List of Priority Habitats (http://jncc.defra.gov.uk/page-5718) and the EUNIS (European Nature Information System) habitat type and species codes, as well as reference to the Northwest Atlantic Fisheries Organization (NAFO), the International Council for the Exploration of the Seas (ICES) and the Food and Agricultural Organization of the United Nations (FAO) for vulnerable marine ecosystems. Finally, some useful references for the region are listed where possible under "Further Information".

Each benthic habitat or feature was generally ranked against the DFO EBSA criteria and the additional CBD criteria of Vulnerability, Biological Productivity and Biological Diversity (some overlap exists amongst these and the DFO criteria- note that Vulnerability is inversely related to Resilience) (Tables 1, 2, 3). A guide to the ranking was created *a priori* following DFO (2004). Assigned species/habitat ranks are based on the global scientific literature and should be considered as general guides only and suspected benthic EBSAs should be re-evaluated on a case by case basis with regionally-specific information.

Table 1. Generalized evaluation of 14 structure-forming benthic biogenic habitats known or likely to occur in DFO Maritimes Region against DFO and additional CBD EBSA criteria. Evaluation scores follow DFO (2011).

		DFO EBSA Criteria (DFO, 2007)					Additional CBD EBSA Criteria		
Benthic Habitat		**Uniqueness**	**Aggregation**	**Fitness Consequences**	**Resilience**	**Naturalness**	**Vulnerability**	**Biological productivity**	**Biological diversity**
Structural Habitat Feature (S)	High	Geographic scale and species composition of the assemblage is regionally or globally unique	High density and size of reef or bed structure, high density associated with high number of species	Older/larger individuals provide greater population fecundity and community structure; low dispersal capability; aggregations contribute to reproductive success	Fast growing species; habitat structures or species are robust, resistant to perturbation or readily return to the pre-perturbation state	Relatively undisturbed and extremely old pristine habitat	Foundation species fragile (easily damaged), sensitive to disturbance and slow to recover from disturbance	High productivity relative to other habitats in the area	Creates habitat for a large number of species; some obligate habitat associations
	Low	Geographic scale and species composition of the assemblage is found repeatedly	Low density and size of reef or bed structure, low number of species associated with habitat	Individual size /age has little influence on population fecundity and community structure; long range dispersal; aggregations not strongly associated with reproductive success	Long-lived, slow growing species with long recovery time after physical disturbance	Habitat altered by structural (landslide, storm) or anthropogenic disturbance (e.g. trawling)	Foundation species not fragile (not easily damaged), not sensitive to disturbance and quick to recover from disturbance	Low productivity relative to other habitats in the area	Creates habitat for only a few other species; no obligate habitat associations; local increase in species richness and abundance associated with habitat
Eelgrass Beds		Low	High	High	Medium	Variable	Medium	High	High
Kelp Forests		Low	High	High	Medium	Variable	Medium	High	High

Benthic Habitat		Uniqueness	Aggregation	Fitness Consequences	Resilience	Naturalness	Vulnerability	Biological productivity	Biological diversity
Rhodolith Beds		High	Medium	High	Low	High	High	Low	Medium
Horse Mussel Reefs		High	High	High	Low	High (?)	High	Medium	High
Oyster Beds		High	High	High	Low	High	High	Medium	High
Sea Pen Fields		Low	Low-Medium	High	Low	Variable	High	Low	Low
Soft Coral Gardens		Low	Low-Medium	Low	High	Low	Low	Medium	Medium
Large Corals on Hard Substrates		High	High	High	Low	High	High	Low	High
Lophelia pertusa Reefs		High	High	High	Medium	Low	Medium	Low	High
Sponge Aggregations		Low-High	High	High	Low	Variable	High	Low	High
Tube-Dwelling Anemone Fields		Medium	Medium	Medium-High	Medium	Low	Medium	Low	Low
Erect Bryozoan Turf		Low-High	High	Low-Medium	Low-Medium	Low	Medium-High	Low	High
Crinoid Beds		?	Medium	Medium	Low	?	High	Low	?
Stalked Tunicate Fields		High	Low	Medium	Low-Medium	Low	Medium-High	Low	High

Table 2. Generalized evaluation of 4 species groups with key bioturbating function known or likely to occur in DFO Maritimes Region against DFO and additional CBD EBSA criteria. Evaluation scores follow DFO (2011).

		DFO EBSA Criteria (DFO, 2007)					**Additional CBD EBSA Criteria**		
Benthic Habitat		**Uniqueness**	**Aggregation**	**Fitness Consequences**	**Resilience**	**Naturalness**	**Vulnerability**	**Biological productivity**	**Biological diversity**
Bioturbator (F)	High	Geographic scale is regionally or globally unique	High density or large area of influence, large number of species affected by bioturbation	Older/larger individuals provide greater population fecundity or impact on community structure; aggregations contribute to reproductive success	Short-lived, fast growing species with medium recovery time after physical disturbance	Relatively undisturbed habitat	Species fragile (easily damaged), sensitive to disturbance and slow to recover from disturbance	High productivity relative to other habitats in the area created through bioturbation	Creates habitat for a large number of species; some obligate habitat associations; enhances ecosystem function
	Low	Geographic scale is found repeatedly; species common	Low density or only immediate area of influence, low number of species affected by bioturbation	Individual size /age has little influence on population fecundity or impact on community structure; aggregations not strongly associated with reproductive success	Long-lived, slow growing species with long recovery time after physical disturbance	Habitat altered by structural (landslide, storm) or anthropogenic disturbance (e.g. trawling)	Species not fragile (not easily damaged), not sensitive to disturbance and quick to recover from disturbance	Low productivity relative to other habitats in the area; bioturbation has little or no effect on productivity	Creates habitat for only a few other species; *local* increase in species richness and abundance associated with habitat
Xenophyo-phore Fields		High	Medium – High	Low-Medium	Low-Medium	High?	High	Medium	Medium
Brittle Star Beds		Variable	Medium	Low-Medium	High	Low	Low-Medium	Low	High
Sublittoral Clam Beds		Low	Medium – High	Low-Medium	Low	Variable	High	Low	High
Sand Dollar Beds		Low-Medium	High	Medium	High	Variable	Low	Low	High

Table 3. Generalized evaluation of 4 benthic physical features which may be proxies for EBSAS against DFO and additional CBD EBSA criteria. Evaluation scores follow DFO (2011).

		DFO EBSA Criteria (DFO, 2007)					Additional CBD EBSA Criteria		
Benthic Feature		**Uniqueness**	**Aggregation**	**Fitness Consequences**	**Resilience**	**Naturalness**	**Vulnerability**	**Biological productivity**	**Biological diversity**
Strong topography (P)	High	Feature is regionally or globally unique	Feature generates unique habitat conditions influencing density of species and diversity	Feature contributes to reproductive success (forcing proximity; creating stepping stones)	Feature relatively stable	Relatively undisturbed or not affected by anthropogenic disturbance	Species associated with habitat fragile (easily damaged), sensitive to disturbance and slow to recover from disturbance	High productivity relative to other habitats in the area created through bioturbation	Creates habitat for a large number of species; some obligate habitat associations; enhances ecosystem function
	Low	Feature is found repeatedly	Feature has little effect on density of species or diversity	Feature has little effect on reproduction or fitness of associated species	Feature transient	Feature vulnerable to anthropogenic disturbance	Species associated with habitat not fragile (not easily damaged), not sensitive to disturbance and quick to recover from disturbance	Low productivity relative to other habitats in the area; bioturbation has little or no effect on productivity	Creates habitat for only a few other species; *local* increase in species richness and abundance associated with habitat
Glacial Erratics and Morraines		Low-Medium, scale dependent	High	Medium	High	Variable	Variable	High	High
Canyons		Medium	High	High	High	Variable	High	High	High
Steep Slopes		Medium	High	?	High	High	High	?	Medium
Pockmarks		Low	Low	?	Medium	Medium	Low	Low	Low

1.1 References

DFO. 2004. Identification of Ecologically and Biologically Significant Areas. DFO Can. Sci. Adv. Sec. Sci. Adv. Rep. 2004/051.

DFO. 2011. Ecologically and Biologically Significant Areas – Lessons Learned. DFO Can. Sci. Adv. Sec. Sci. Adv. Rep. 2011/049.

FAO. 2009. Report of the Technical Consultation on International Guidelines for the Management of Deep-sea Fisheries in the High Seas. Rome, 4–8 February and 25–29 August 2008. ftp://ftp.fao.org/docrep/fao/011/i0605t/i0605t00.pdf

2 STRUCTURE-FORMING BENTHIC BIOGENIC HABITATS

2.1 Eelgrass (Zostera marina) Beds

Zostera marina bed off Nova Scotia (downloaded from http://www.fmap.ca/ramweb/media/patterns_predictors/images/Seagrass.jpg)

2.1.1 Description

Seagrasses are underwater plants that are usually perennial, with an extensive network of underground roots and rhizomes. The seagrass shoots are characterized by both vegetative foliage leaves and sexually reproductive stems. The flowering shoots can be dislodged by wave action and distributed by currents over 100 km distant. Seagrasses occur worldwide but only one species is widespread in Atlantic Canada, *Zostera marina*, also known as eelgrass. It is the dominant seagrass found in coastal and estuarine areas of the western North Atlantic. It can form extensive beds over the full range of low intertidal to subtidal habitat (down to 12 m depth in some areas) and from sheltered

areas to exposed coasts. Eelgrass occurs predominantly in a mono-culture throughout most of its distribution but can overlap with widgeon grass (*Ruppia maritima*) in the upper low salinity portions of estuaries in Atlantic Canada.

2.1.2 Ecological or biological significance

Seagrass beds are important for sediment deposition, substrate stabilization, as substrate for epiphytic species, micro-invertebrates, and as habitat for many fish species. Seagrass beds are very productive (an estimated 2g C/m^2/day during the growing season in temperate areas) and often contain a large biomass (up to 5kg/m^2). The living plant is a major source of food for wildfowl, particularly Canada geese. Only about 5% of seagrass production is thought to be consumed directly and it may be that the dead plant is more important because it is an abundant source of organic matter for marine systems. Eelgrass provides three dimensional structure which is considered to be important to increasing biodiversity and productivity. DFO has previously determined that eelgrass meets the criteria as an Ecologically Significant Species. An invasive green crab has been implicated in the decline of many eelgrass beds in Nova Scotia and in the past the species has been subjected to mass mortality caused by a wasting disease.

2.1.3 Correspondence with listed habitats in other jurisdictions

OSPAR habitat: *Zostera* beds

Habitats Directive –Annex 1: Mudflats and sandflats covered by water at low tide

EUNIS (European Nature Information System) habitat type code: A5.533 (May 2007): *Zostera* beds in full salinity infralittoral sediments

Biodiversity Action Plan Priority Habitats (UK): Sublittoral seagrass beds; Sublittoral macrophyte-dominated sediments

2.1.4 Further Information

Eelgrass have been well studied in the Maritimes region both through DFO and university publications. There are many references available and only a few were chosen here:

DFO. 2009. Does eelgrass (*Zostera marina*) meet the criteria as an ecologically significant species? DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2009/018.

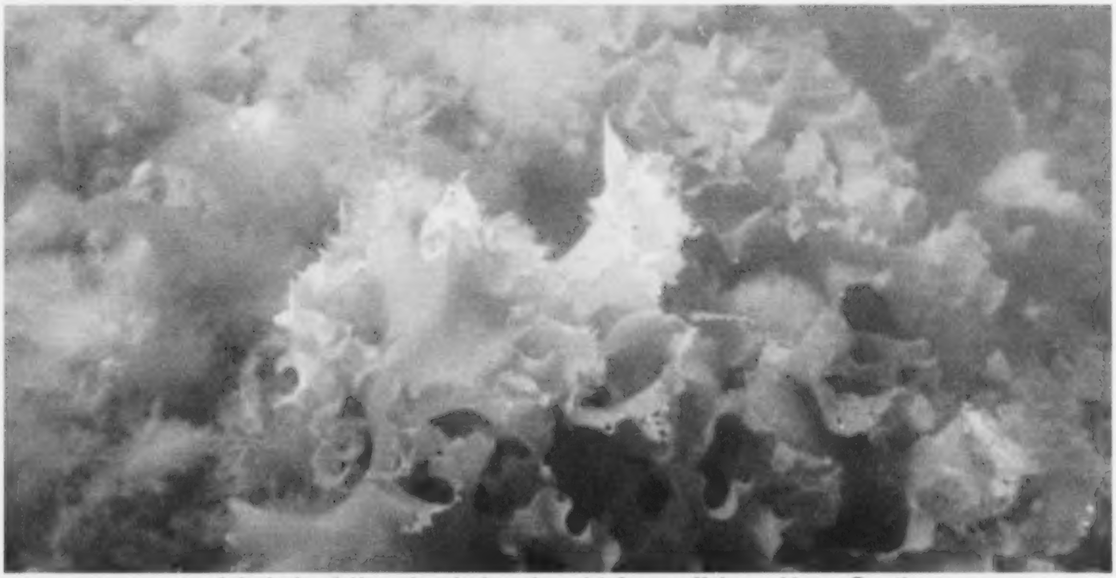
Hanson, A.R. (ed.) 2004. Status and conservation of eelgrass (*Zostera marina*) in Eastern Canada. Technical Report Series No. 412. Canadian Wildlife Service, Atlantic Region. viii. + 40 pp.

Larkum, A.W.D., Orth, R. J. and Duarte, C. (Eds.). 2006. Seagrasses: Biology, Ecology and Conservation. Springer-Verlag.

Tyrrell, M.C. 2005. Gulf of Maine Marine Habitat Primer. Gulf of Maine Council on the Marine Environment, vi+54 pages. www.gulfofmaine.org

Vandermeulen, H. 2009. An Introduction to Eelgrass (*Zostera marina* L.): The Persistent Ecosystem Engineer. DFO Can. Sci. Advis. Sec. Res. Doc. 2009/085.

2.2 Kelp Forests



A kelp bed (*Laminaria longicruris*) from offshore Nova Scotia (http://www.fisherycrisis.com/Galleries/kelpgallery.htm)

2.2.1 Description

Kelp species represent the largest and morphologically most complex brown algae and are comprised of different genera largely of the Order Laminariales. Kelps are the most prominent constituents of the lower intertidal and subtidal of Atlantic and Pacific rocky shores of temperate regions of both the Northern and Southern Hemisphere. As canopy algae they often form dense beds, referred to as kelp forests, supporting a rich understorey flora and fauna. In Nova Scotia the two dominant kelp species are *Laminaria longicruris* and *L. digitata. Alaria esculenta, Agarum cribosum* and *Saccorhiza dermatodea* may be locally abundant. Worldwide, kelp forests sustain a high diversity of fish and are the source of raw material for the alginate industry. Major factors in determining the biogeographical distribution of kelp species are the winter and summer seawater isotherms that set the limits for survival and reproduction. The basic structure of kelp consists of a holdfast (mostly branching root-like structures that anchor the kelp to the substratum), a long flexible stipe and a frond (also called a blade or lamina). The vertical distribution or zonation of kelp species on subtidal rocky substrata results from their responses to a number of factors such as light penetration, wave exposure, competition, grazing and tolerance to emersion.

There is considerable variation in the densities of the *Laminaria longicruris* populations in Nova Scotia. These variations are not clearly related to the size class composition of the populations. In a population (close to Halifax) with the highest density recorded (24.0 m^2 SE = 4.0) the average plant mass was relatively low (228.5 g SE = 20.8). In southwestern Nova Scotia, where average plant mass is higher, densities tend to be lower. Off Bon Portage Island on the southwestern shore of Nova Scotia densities of

Laminaria longicruris varied between 3.8 and 14.2 m along a gradient of increasing shelter to wave action.

2.2.2 Ecological or biological significance

Kelp forests have been described as one of the most ecologically dynamic and biologically diverse habitats on the planet. Kelp species are considered as *Keystone Species* or species whose presence affects the survival and abundance of many other species in the ecosystem. Their removal is likely to result in a relatively significant shift in the composition of the community and perhaps in the physical structure of the environment. Clearly the removal of kelp species will have obvious negative effects on the invertebrate species that live in the holdfast, the stipe or fronds or under the fronds. Additionally, mucus and cellular material that is continually being lost from kelp forests fuels a complex recycling system of bacteria, herbivores, direct and indirect suspension feeders and eventually carnivores. Kelp forests are susceptible to overgrazing by sea urchins.

2.2.3 Correspondence with listed habitats in other jurisdictions

Habitats Directive – Annex 1: Reefs and large shallow inlets and bays
Biodiversity Action Plan Priority Habitats (UK): Tide-swept channels
EUNIS (European Nature Information System) habitat type code: A3.21 (EUNIS Habitat Classification 2012 - a revision of the habitat classification descriptions): Kelp and red seaweeds (moderate energy infralittoral rock)

2.2.4 Further Information

Kelp have been well studied in the Maritimes region both through DFO and university publications. There are many references available and only a few were chosen here as they provide distributional information:

Chapman, A.R.O. 1987. The wild harvest and culture of *Laminaria longicruris* in Eastern Canada. FAO Fisheries Technical Paper. T281. http://www.fao.org/docrep/x5819e/x5819e08.htm

Gratto, G.W. and Bleakney, J.S. 1985. Discovery of an extensive area of *Laminaria saccharina* in Minas Basin, Nova Scotia. *Proc. Nova Scotia Inst. Sci.* 35.

Sharp, G.J. 1986. Biomass and population structure of kelp (*Laminaria* spp.) in southwestern Nova Scotia. Can. Man. Rep. Fish. Aquatic Sci. No. 1907.

Tyrrell, M.C. 2005. Gulf of Maine Marine Habitat Primer. Gulf of Maine Council on the Marine Environment, vi+54 pages. www.gulfofmaine.org

2.3 *Rhodolith Beds*

A shallow rhodolith bed with filamentous algal overgrowth.

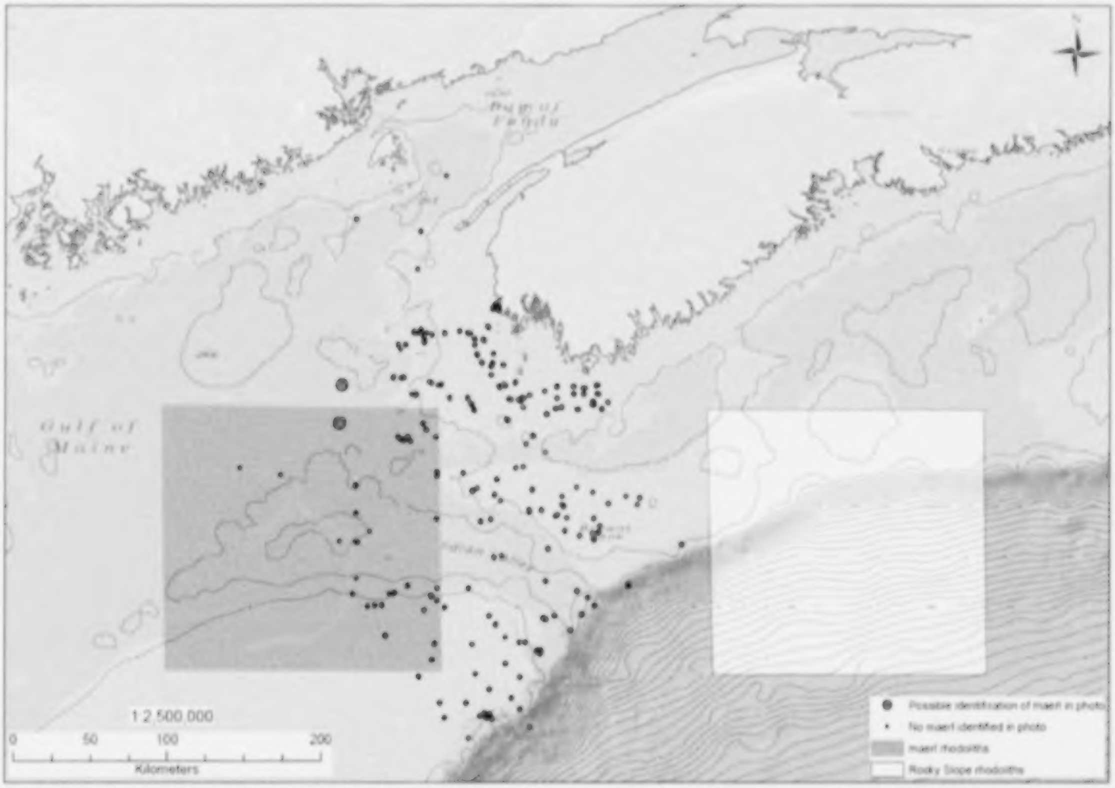
2.3.1 Description

Rhodolith is a generic name for certain coralline (Rhodophyta, Corallinaceae) algae that grow unattached on the sea bed as free-living balls, branched twigs, or rosettes. They are also referred to as Maerl, particularly in the United Kingdom. High concentrations of living rhodoliths can be found from the low intertidal zone down to 150 m water depth, typically in areas where the light regime is suitable for growth. Rhodoliths can form extensive beds (aggregations) overlying calcareous sediments produced by the accumulation of eroding rhodolith fragments. These beds typically occur in environments where water motion (waves and currents) or bioturbation are strong enough to move individual rhodoliths within beds, thereby preventing burial by sediments or overgrowth by other organisms, but not so high as to cause their destruction. On the eastern coast of Canada rhodoliths are formed by the coralline algae species *Lithothamnion glaciale* which also grows as an attached alga. This species is distributed in the western North Atlantic from Greenland and Arctic Canada to Massachusetts and in the eastern North Atlantic from Icleand and Arctic Norway to France and the British Isles. Rhodoliths have been reported from the coast of Labrador and eastern Newfoundland. Records form the late 19th century show rhodoliths to be present off Nova Scotia, although this has not been verified recently. They are long-lived often reaching ages of more than 100 years.

2.3.2 Ecological or biological significance

Coralline algae may be one of the largest stores of carbon in the biosphere. All plants take up carbon during photosynthesis, but coralline algae deposit large amounts of carbon in their cell walls in the form of calcium carbonate. Maerl beds provide a

complex habitat for a wide range of taxa with a variety of niches that support high associated invertebrate and algal biodiversity. Maerl beds act as nursery areas for the juvenile stages of fish and invertebrate species.



The locations of Maerl (dark box) and rocky slope rhodoliths (open box) in Atlantic Canada from Bosence (1983b). Location of underwater images collected by NRCan are indicated. Those in red show possible rhodolith presence.

2.3.3 Correspondence with listed habitats in other jurisdictions

OSPAR habitat: Maerl beds

EUNIS (European Nature Information System) habitat type code: (EUNIS Habitat Classification 2012 - a revision of the habitat classification descriptions): A5.51 Maerl beds; A4.65 Maerl beds on deep-water muddy sediments

Biodiversity Action Plan Priority Habitats (UK): 41 – Maerl beds

Habitats Directive: Two maerl-forming species, *Lithothamnium corallioides* and *Phymatolithon calcareum*, are listed in Annex V of the Habitats Directive and in some locations maërl is also a key habitat within some of the Annex I habitats of the Directive and therefore given protection through the designation of Special Areas of Conservation.

2.3.4 Further Information

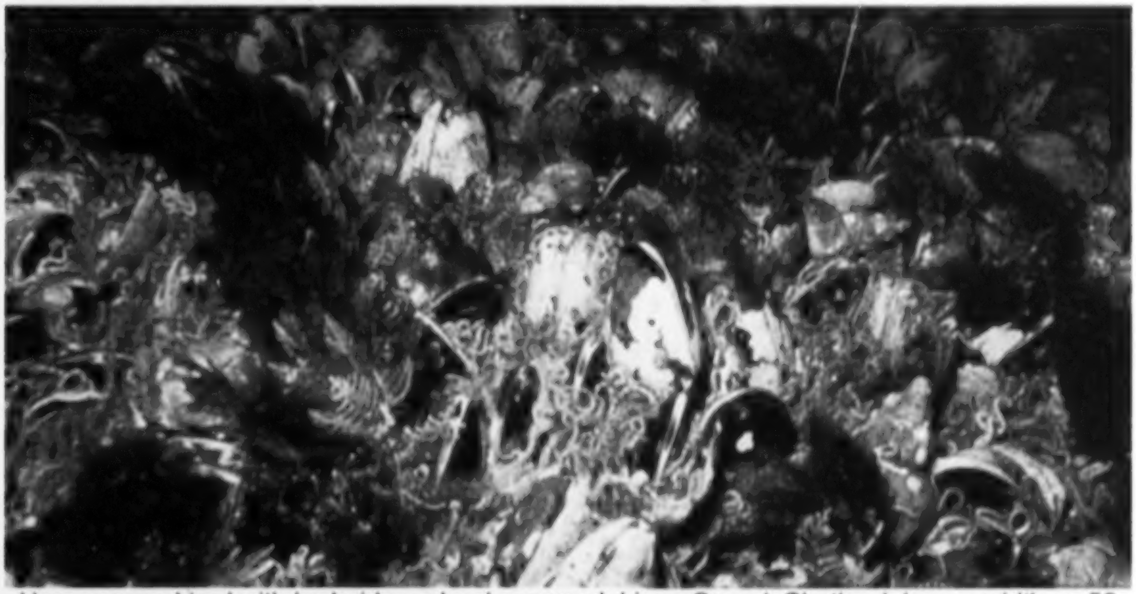
Bosence D.W.J. 1983a. Description and classification of Rhodoliths (Rhodoids, Rhodolites). In: T.M. Peryt (Ed.), Coated grains, Springer-Verlag, Berlin, pp. 217-224.

Bosence D.W.J. 1983b. The occurrence and ecology of recent rhodoliths – a review. In: T.M. Peryt (Ed.), Coated grains, Springer-Verlag, Berlin, pp. 225-242.

Foslie, M. 1894. The Norwegian forms of *Lithothamnion*. D. Kgl. Norsek Vidensk Selske Skr. 2: 203.

Foster M.S. 2001. Rhodoliths: between rocks and soft places. J. Phycol. 37: 659-667.

2.4 Horse Mussel (Modiolus modiolus) Beds



Horse mussel bed with hydroids and red seaweed, Linga Sound, Shetland. Image width ca 50 cm. Downloaded from http://www.marlin.ac.uk/generalbiology.php?speciesID=3817#

2.4.1 Description

Modiolus modiolus is a medium-sized (10-20 cm) bivalve belonging to the Family Mytilidae (Mussels). The horse mussel, *M. modiolus*, may form dense beds or reefs, at depths up to 100m, mostly in fully saline conditions and often in tide-swept areas. Although *M. modiolus* is a widespread and common species in our waters, horse mussel beds (with typically ≥ 30% cover) are more limited in their distribution. Coarse sediment banks formed by horse mussel beds form wave-like mounds or bioherms in the Bay of Fundy. These have been recorded using sidescan sonar as up to 3 m high and 20 m wide and 10s -100s of metres in length. Approximately 1500 possible mussel beds have been mapped in the Bay of Fundy, with a total area of 11,670,283 square meters. Similar bioherms have not been documented outside of the Bay of Fundy. *M. modiolus* is a long-lived species and individuals within beds have been aged to 48 yrs. Horse mussel beds, reefs and bioherms are extremely vulnerable to damage by bottom-contact fishing gears and have shown very poor recovery capacity.

2.4.2 Ecological or biological significance

The byssus threads of *M. modiolus* have an important stabilising effect on the seabed, binding together living *M. modiolus*, dead shell and sediments. As *M. modiolus* is a filter feeder the accumulation of faeces and pseudofaeces represents an important flux of organic material from the plankton to the benthos. Communities associated with *Modiolus* beds are diverse, with a wide range of epibiota and infauna, including hydroids, bryozoans, sponges, soft corals, brittlestars, bivalves and ascidians amongst others.

2.4.3 Correspondence with listed habitats in other jurisdictions

OSPAR habitat : *Modiolus modiolus* beds

Habitats Directive –Annex 1: Large shallow inlets and bays and Reefs

EUNIS (European Nature Information System) habitat type code: A5.622 (May 2007): *Modiolus modiolus* beds on open coast circalittoral mixed sediment

Biodiversity Action Plan Priority Habitats (UK): Sublittoral biogenic reefs; Sublittoral mussel beds on sediment

2.4.4 Further Information

Cook, R., Fariñas-Franco, J.M., Gell, F.R., Holt, R.H.F., Holt, T. *et al.* 2013. The substantial first impact of bottom fishing on rare biodiversity hotspots: A dilemma for evidence-based conservation. PLoS ONE 8(8): e69904. doi:10.1371/journal.pone.0069904

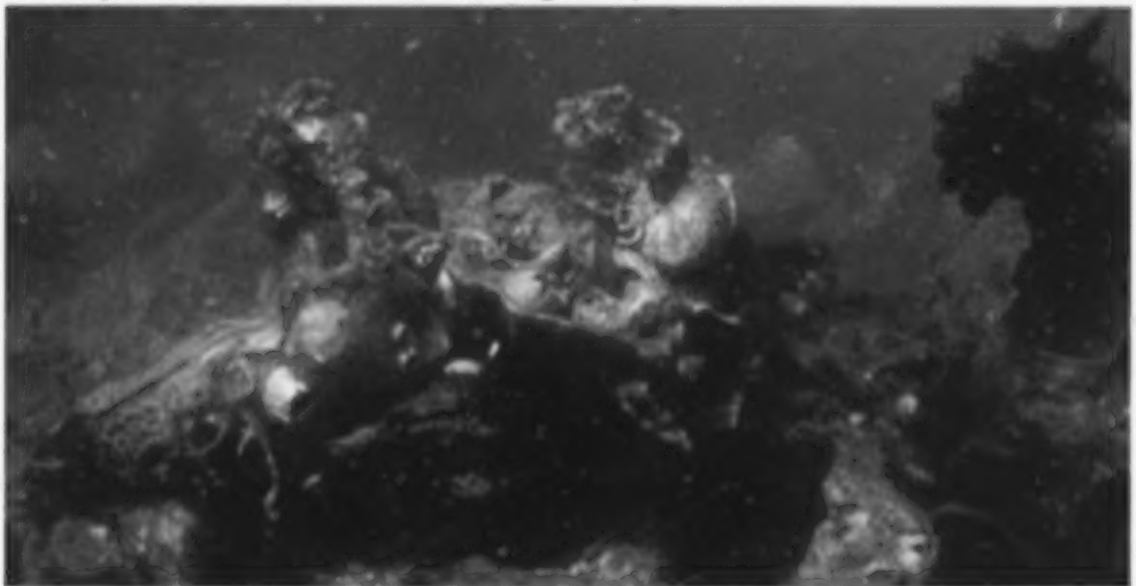
Kostylev, V.E., Parrott, D.R., Dickson, R. and Todd, B.J. 2009. Distribution and morphology of horse mussel beds in the Bay of Fundy identified using multibeam sonar. 8th International Conference, GeoHab - marine geological and biological habitat mapping; Trondheim; NO; May 5-7, 2009, p. 49.

Wildish, D.J. and Fader, G.B.J. 1998. Pelagic-benthic Coupling in the Bay of Fundy. Hydrobiologia 375/376:369-380.

Wildish, D.J., Fader, G.B.J., Lawton, P. and MacDonald, R.J. 1998. The Acoustic Detection and Characteristics of Sublittoral Bivalve Reefs in the Bay of Fundy. Con. Shelf Res. 18:105-113.

Wildish, D., Akagi, H., Hatt, B., Hamilton, *et al.* 1998. Population analysis of horse mussels of the inner Bay of Fundy based on estimated age, valve allometry and biomass. Can. Tech. Rep. Fish. Aquat. Sci. 2257: iv + 43 p.

2.5 *Oyster Beds (Crassostrea virginica)*



Oyster reef from Chesapeake Bay, Massachusetts, USA. Downloaded from www.chesapeakebay.net

2.5.1 Description

Eastern oysters (*Crassostrea virginica*) are sessile epibenthic organisms that inhabit dynamic environments such as estuarine and coastal waters. On the outside, the shell is grey with some brown, green and white shades. On the inside, the shell is white except for the muscle scar area which is deep purple. The eastern oyster is widely distributed along the western Atlantic shores, ranging from northern temperate to sub-tropical environments. They are commonly found in shallow estuarine waters, but can occur at depths of about 30 meters. Most eastern oyster reefs north of Cape Fear, North Carolina, are found in subtidal areas and grow on bottoms that are covered with water throughout the tidal cycle. In the Maritimes, the eastern oyster grows in both intertidal and subtidal areas. Those growing in intertidal zones are exposed to freezing air temperatures and ice scouring during the winter months, which may limit their chances of survival. Small populations exist in Cape Breton's Bras d'Or Lake, Aspey Bay and in Ragged Head in Chedabucto Bay. They are also found naturally along the eastern shore of Nova Scotia but records elsewhere are sporadic and they appear to have been greatly reduced in the Bay of Fundy from historical times where middens show extensive collections of oyster shells there.

Oyster reproduction is affected by temperature, salinity, food availability and water quality. The sexes are separate with females producing up to 70 million eggs per year. Size at maturity is 25mm shell length. Spawning occurs if water temperatures reach 20°C (early June/late July) generally at midday low tides. Fertilized eggs become pelagic larvae which swim in the water column for about 21 days, whereupon they attempt to locate a clean firm substrate for permanent attachment. Outbreak of the

lethal Malpeque disease wiped out many oyster beds during the 1950's (with the exception of Cape Breton).

2.5.2 Ecological or biological significance

Oysters influence nutrient cycling (benthic pelagic coupling), water filtration, habitat structure, biodiversity, and food web dynamics. In addition to providing a hard surface for the attachment of many sessile marine organisms, oyster beds and reefs also provide refuges and feeding grounds for various mobile marine organisms such as crustaceans, worms, molluscs and fish.

2.5.3 Correspondence with listed habitats in other jurisdictions

OSPAR habitat : *Ostrea edulis* beds

EUNIS (European Nature Information System) habitat type code: A5.435 (EUNIS Habitat Classification 2012 - a revision of the habitat classification descriptions): Oyster beds on shallow sublittoral muddy mixed sediment

Biodiversity Action Plan Priority Species (UK): *Ostrea edulis*

Habitats Directive –Annex 1: Open seas and tidal areas: 1170 Reefs

2.5.4 Further Information

Abgrall, M.-J., Bastien-Daigle, S., Miron, G. and Ouellette, M. 2010. Potential interactions between populations of Softshell Clams (*Mya arenaria*) and Eastern Oysters (*Crassostrea virginica*) in temperate estuaries, a literature review. Can. Tech. Rep. Fish. Aquat. Sci. 2892 vii + 88 p.

DFO. 1996. Cape Breton American Oyster. DFOAtlantic Fisheries Stock Status Report 96/124E. http://www.dfo-mpo.gc.ca/csas/Csas/status/1996/SSR_1996_124_e.pdf

Kennedy, V.S., Newell, R.I.E. and A.F. Eble, editors 1996. The Eastern Oyster *Crassostrea virginica*. Maryland Sea Grant College, Maryland, U.S.A. 731pp.

Smyth, A., Geraldi, N.R. and Piehler, M.F. 2013. Oyster-mediated benthic-pelagic coupling modifies nitrogen pools and processes. Mar. Ecol. Prog. Ser. 493:23-30.

Vercaemer B., St-Onge, P., Spence, K., Gould S. and McIsaac, A. 2010. Assessment of biodiversity of American oyster (Crassostrea virginica) populations of Cape Breton, N.S. and the Maritimes. Can. Tech. Rep. Fish. Aquat. Sci. 2872: vi + 32 p.

2.6 Sea Pen Fields

Grenadier resting in a sea pen field in Desbarres Canyon, southwest Grand Banks of Newfoundland (depth 905 m).

2.6.1 Description

Sea pens belong to the Cnidarian order Pennatulacea. Unlike other octocorals, a sea pen's polyps are specialized to specific functions: a single polyp develops into a rigid, erect stalk (the rachis) and loses its tentacles, forming a bulbous "root" or peduncle at its base which anchors it in the soft sediments of the sea floor. The stalks can be over 1.5 metres long with larger species reaching up to 50 yrs. Usually sea pens stay in one spot but they are able to uproot themselves and relocate over small distances. Some can also forcibly expel water out of themselves propelling deep into the sediments (e.g., *Protoptilum carpenteri*).

2.6.2 Ecological or biological significance

Aggregations of sea pens provide important structure in low-relief sand and mud habitats where there is little physical habitat complexity. They provide refuge for small planktonic and benthic invertebrates and fish larvae (redfish) which in turn may be preyed upon by fishes. They also alter water current flow, thereby retaining nutrients and entraining plankton near the sediment. They may be associated with corals living in soft sediments (e.g. *Acanella* sp., *Radicipes* sp. *Flabellum* sp.).

2.6.3 Correspondence with listed habitats in other jurisdictions

OSPAR habitat: Sea-pen and burrowing megafauna communities

NAFO Vulnerable Marine Ecosystem: Sea pens (*Anthoptilum grandiflorum*, *Funiculina quadrangularis*, *Halipteris* spp., *Kophobelemnon stelliferum*, *Pennatula* spp., *Distichoptilum gracile*, *Protoptilum* sp., *Umbellula lindahli*, *Virgularia* cf. *mirabilis*)

ICES VME Indicator Species: 4. Seapen fields

Biodiversity Action Plan Priority Habitats (UK): Mud habitats in deep water (circalittoral muds)

2.6.4 Further Information

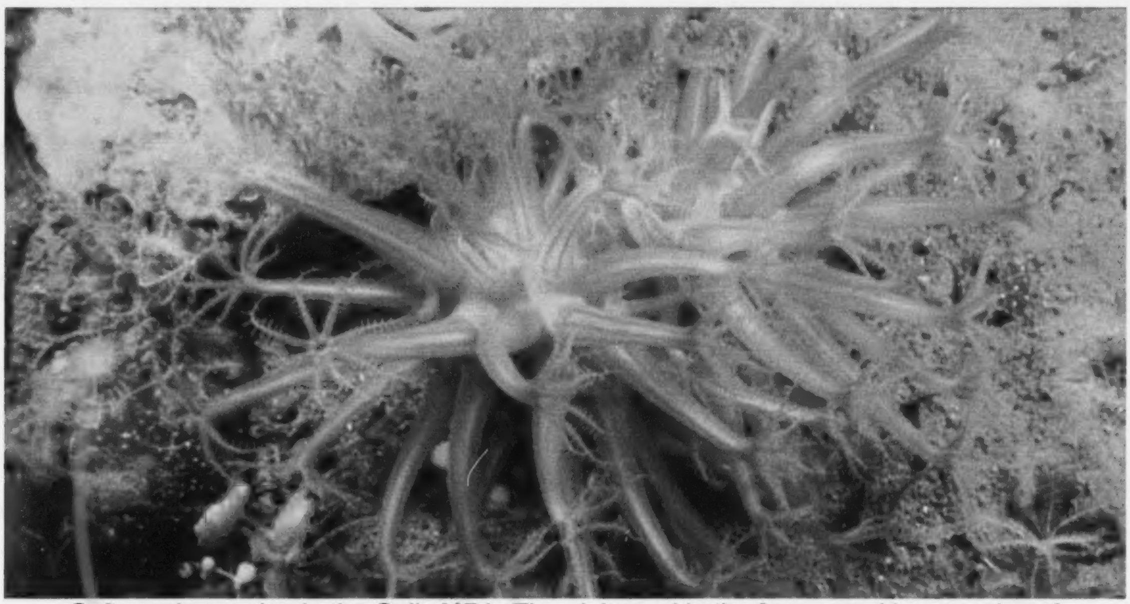
Baillon, S., Hamel, J.F., Wareham, V.E. and Mercier, A. 2012. Deep cold-water corals as nurseries for fish larvae. Frontiers Ecol. Environ. 10: 351–356.

Cogswell, A.T., Kenchington, E.L.R., Lirette, C.G., MacIsaac, K.G., Best, M.M., Beazley, L.I. and Vickers, J. (2009). The current state of knowledge concerning the distribution of coral in the Maritime Provinces. Can. Tech. Rep. Fish. Aquat. Sci. 2855: v + 66 pp.

Kenchington, E., Lirette, C., Cogswell, A., Archambault, D., Archambault, P., Benoit, H., Bernier, D., Brodie, B., Fuller, S., Gilkinson, K., Levelsque, M., Power, D., Siferd, T., Treble, M. and Wareham, V. 2010. Delineating Coral and Sponge Concentrations in the Biogeographic Regions of the East Coast of Canada Using Spatial Analyses. DFO Can. Sci. Adv. Sec. Res. Doc. 2010/041. iv + 207 pp.

Kenchington, E., Murillo, F.J., Cogswell, A. and Lirette, C. 2011. Development of Encounter Protocols and Assessment of Significant Adverse Impact by Bottom Trawling for Sponge Grounds and Sea Pen Fields in the NAFO Regulatory Area. NAFO Sci. Coun. Res. Doc. 11/75, 53 pp.

2.7 *Soft Coral Gardens*



Soft corals growing in the Gully MPA. The pink coral in the foreground is a species of *Anthomastus*. A second species is seen in the top left with pale white tentacles.

2.7.1 Description

The generic term soft coral refers to corals of the cnidarian Order Alcyonacea, and here specifically to the Families Nephtheidae and Alcyoniidae. Soft corals do not produce external calcium carbonate skeletons – hence the name- and are commonly found over

most of eastern Canada from the shallow subtidal to the continental slopes and are frequently caught in trawl gear. Common species on the Scotian Shelf are *Gersemia rubiformis* (*Eunephthya rubiformis*), *Duva florida*, *Capnella glomerata* (Nephtheidae) and *Anthomastus grandiflorus* (Alcyoniidae) although early records may be mis-diagnosed and the taxonomy of this group has been revised in recent years. Soft corals attach to hard substrate and can be found on bedrock or on cobbles embedded in muds or sands.

Some nephtheids are adapted to disturbance and have evolved a fugitive life history by increasing the ability of asexual propagules to migrate into open spaces and act as pioneers of recently disturbed habitats. It has been experimentally demonstrated that *Gersemia rubiformis* can survive repeated disturbances caused by rolling and crushing, although a weakening of the stalk was eventually produced and colonies may have prematurely aborted planulae producing daughter colonies that had high mortality in the lab. Direct removals of soft corals as by-catch can quickly depopulate an area.

2.7.2 Ecological or biological significance

Experimental removal of high densities of soft corals has been shown to produce no significant changes in the associated fish communities (diversity) and the heterogeneity of habitat generated by soft corals can be indistinguishable from equivalent habitat formed by rock alone. However, in a preliminary examination of relationships between corals and groundfish in NAFO Divisions 2GH and 0B a statistically significant association of juvenile Northern shrimp and snow crab with soft corals has been documented.

2.7.3 Correspondence with listed habitats in other jurisdictions

OSPAR habitat: Coral gardens. "Coral gardens" means a relatively dense aggregation extending over at least $25m^2$ of colonies or individuals of one or more coral species, such as leather corals (Alcyonacea), gorgonians (Gorgonacea), sea pens (Pennatulacea), black corals (Antipatharia), hard corals (Scleractinia) and, in some places, stony hydroids (lace or hydrocorals: Stylasteridae). This habitat is described further in the OSPAR Agreement on working definitions for OSPAR priority habitats (OSPAR Agreement 2008 7).

ICES VME Indicator Species: 2. Coral Gardens; B. Soft-bottom coral gardens; iii. Cauliflower coral fields

FAO Annex: Examples of potentially vulnerable species groups, communities and habitats, as well as features that potentially support them- certain coldwater corals and hydroids, e.g. reef builders and coral forest including: stony corals (Scleractinia), alcyonaceans and gorgonians (Octocorallia), black corals (Antipatharia) and hydrocorals (Stylasteridae)

2.7.4 Further Information

Cogswell, A.T., Kenchington, E.L.R., Lirette, C.G., MacIsaac, K.G., Best, M.M., Beazley, L.I. and Vickers, J. 2009. The current state of knowledge concerning the distribution of coral in the Maritime Provinces. Can. Tech. Rep. Fish. Aquat. Sci. 2855: v + 66 pp.

Kenchington, E., Lirette, C., Cogswell, A., Archambault, D., Archambault, P., Benoit, H., Bernier, D., Brodie, B., Fuller, S., Gilkinson, K., Levelsque, M., Power, D., Siferd, T., Treble, M. and Wareham, V. 2010. Delineating Coral and Sponge Concentrations in the Biogeographic Regions of the East Coast of Canada Using Spatial Analyses. DFO Can. Sci. Adv. Sec. Res. Doc. 2010/041. iv + 207 pp.

Watling, L., and Auster, P. 2005. Distribution of deep-water Alcyonacea off the Northeast Coast of the United States. In: Freiwald, A., R.J. Murray, editors. Cold-Water Corals and Ecosystems. Proceedings of the Second Deep-Sea Coral Symposium, Erlangen, Germany, September 2003. Springer-Verlag Berlin Heidelberg, pp 279-296.

2.8 Large Corals on Hard Substrates

Bamboo coral (*Keratoisis* sp.) growing in the Gully MPA.

2.8.1 Description

The common large upright corals on the Scotian Shelf and slopes belong to the cnidarian Order Alcyonacea Families Isididae, Primnoidae, Chrysogorgiidae, (Suborder Calcaxonia) and Paragorgiidae (Suborder Scleraxonia). These are commonly referred to as gorgonians, sea fans, horny corals and sea feathers. Recent work along the continental slopes using underwater cameras have identified one new genus of black coral (Antipatharia) and records of rare gorgonian coral species (e.g., *Paragorgia johnsonii*). Most species are long-lived, slow-growing and all are colonial species with episodic recruitment and are highly vulnerable to fishing gear. Gorgonians come in a range of sizes from small arborescent forms less than 20 cm to large branching "trees" over 3 metres in height. Each gorgonian polyp has eight tentacles which catch plankton and particulate matter that is consumed. This process, called filter feeding, is facilitated when the "fan" is oriented across the prevailing current to maximise water flow to the gorgonian and hence food supply.

2.8.2 Ecological or biological significance

Deep-water corals provide structural habitat that can be used by other species. This includes the surface of living and dead corals, cavities inside dead skeletons and the spaces between coral branches. Branches can reach up into stronger currents above the benthic boundary layer and feeding advantages are shared with attached filter-feeding organisms. Associated species can also feed on detritus and micro-organisms trapped in coral mucous. Species greater than 1 m in height can profoundly affect benthic community structure. The arboreal-like structure of gorgonians provide habitat for both commercial (redfish) and non-commercial species.

2.8.3 Correspondence with listed habitats in other jurisdictions

OSPAR habitat: Coral gardens. "Coral gardens" means a relatively dense aggregation extending over at least 25m2 of colonies or individuals of one or more coral species, such as leather corals (Alcyonacea), gorgonians (Gorgonacea), sea pens (Pennatulacea), black corals (Antipatharia), hard corals (Scleractinia) and, in some places, stony hydroids (lace or hydrocorals: Stylasteridae). This habitat is described further in the OSPAR Agreement on working definitions for OSPAR priority habitats (OSPAR Agreement 2008 7).

NAFO Vulnerable Marine Ecosystems: Large Gorgonian Corals (*Acanthogorgia armata*, *Iridogorgia* sp., *Keratoisis* spp., *Lepidisis* spp., *Paragorgia* spp., *Paramuricea* spp., *Placogorgia* spp., *Calyptrophora* sp., *Parastenella atlantica*, *Primnoa resedaeformis*, *Thouarella grasshoffi*)

ICES VME Indicator Species: 2. Coral Garden; A. Hard-bottom coral garden; i. Hard-bottom gorgonian and black coral gardens

EUNIS (European Nature Information System) habitat type code: (EUNIS Habitat Classification 2012 - a revision of the habitat classification descriptions): A6.611 Deep-sea *Lophelia pertusa* reefs; A5.631 Circalittoral *Lophelia pertusa* reefs

FAO Annex: Examples of potentially vulnerable species groups, communities and habitats, as well as features that potentially support them- certain coldwater corals and hydroids, e.g. reef builders and coral forest including: stony corals (Scleractinia), alcyonaceans and gorgonians (Octocorallia), black corals (Antipatharia) and hydrocorals (Stylasteridae)

2.8.4 Further Information

Cogswell, A.T., Kenchington, E.L.R., Lirette, C.G., MacIsaac, K.G., Best, M.M., Beazley, L.I. and Vickers, J. 2009. The current state of knowledge concerning the distribution of coral in the Maritime Provinces. Can. Tech. Rep. Fish. Aquat. Sci. 2855: v + 66 pp.

Gordon, D.C. and Kenchington, E.L. 2007. Deep-water corals in Atlantic Canada: a review of DFO research (2001-2003). Proceedings of the Nova Scotia Institute of Science 44:27-50.

Kenchington, E., Lirette, C., Cogswell, A., Archambault, D., Archambault, P., Benoit, H., Bernier, D., Brodie, B., Fuller, S., Gilkinson, K., Levelsque, M., Power, D., Siferd, T., Treble, M. and Wareham, V. 2010. Delineating Coral and Sponge

Concentrations in the Biogeographic Regions of the East Coast of Canada Using Spatial Analyses. DFO Can. Sci. Adv. Sec. Res. Doc. 2010/041. iv + 207 pp.
Mortensen P.B., and Buhl-Mortensen, L. 2005. Coral habitats in The Gully, a submarine canyon off Atlantic Canada. Pages 247–277 in Freiwald A, Roberts JM (eds.), Cold-water corals and ecosystems. Springer-Verlag Berlin Heidelberg.
Tyrrell, M.C. 2005. Gulf of Maine Marine Habitat Primer. Gulf of Maine Council on the Marine Environmentvi+54 pages, www.gulfofmaine.org

2.9 *Lophelia pertusa* Reefs

Lophelia pertusa and a redfish (*Sebastes* sp.) in the Lophelia Coral Conservation Area.

2.9.1 Description

The major reef-building deep-water coral species in the north Atlantic is *Lophelia pertusa*. Off Norway, extensive reefs spread over hundreds of kilometers with the living coral growing over the skeletons of previous generations (forming structures called bioherms). In the northwest Atlantic *L. pertusa* occurs along the continental slopes and banks (200 to 1000 m general depth range) of both Canada (as far north as the Laurentian Channel) and the United States but expansive reef structures and bioherms have not been identified in Canadian waters. A small reef, heavily damaged by the redfish fishery, was found on the Scotian Shelf on SE Banquereau and has been protected as a Coral Conservation Area. Small colonies have been located in the Gully Marine Protected Area.

2.9.2 Ecological or biological significance

Cold-water coral reefs are considered to be ecosystem engineers. Dense aggregations formed by the large structure-forming species which constitute the habitat framework can alter bottom currents and provide niche space for other organisms - often increasing biodiversity compared with surrounding areas. Over 1,300 species of invertebrates have been recorded in an ongoing census of numerous *Lophelia* reefs in the northeast Atlantic. The location of coral reefs can therefore be used as proxies for areas of high biodiversity for both invertebrates and fish species.

2.9.3 Correspondence with listed habitats in other jurisdictions

OSPAR habitat: *Lophelia pertusa* reefs

NAFO/NEAFC/ICES Vulnerable Marine Ecosystem

FAO Annex: Examples of potentially vulnerable species groups, communities and habitats, as well as features that potentially support them- certain coldwater corals and hydroids, e.g. reef builders and coral forest including: stony corals (Scleractinia), alcyonaceans and gorgonians (Octocorallia), black corals (Antipatharia) and hydrocorals (Stylasteridae)

Habitats Directive-Annex 1:Reefs

EUNIS (European Nature Information System) habitat type code: A6.611 (EUNIS Habitat Classification 2012 - a revision of the habitat classification descriptions): Deep-sea *Lophelia pertusa* reefs; A5.631 Circalittoral *Lophelia pertusa* reefs

Biodiversity Action Plan Priority Habitats (UK): (45) *Lophelia pertusa* reefs; A6.6 Deep-sea bioherms; A6.61 Communities of deep-sea corals

2.9.4 Further Information

Cogswell, A.T., Kenchington, E.L.R., Lirette, C.G., MacIsaac, K.G., Best, M.M., Beazley, L.I. and Vickers, J. 2009. The current state of knowledge concerning the distribution of coral in the Maritime Provinces. Can. Tech. Rep. Fish. Aquat. Sci. 2855: v + 66 pp.

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Mortensen, P.B., Buhl-Mortensen, L., Gass, S.E., Gordon, D.C. Jr, Kenchington, E.L.R., Bourbonnais, C. and MacIsaac, K.G. 2006. Deep-water corals in Atlantic Canada: A summary of ESRF-funded research (2001-2003). ESRF Report 143.

2.10 Sponge Aggregations

Vazella pourtalesi on the Scotian Shelf.

2.10.1 Description

Apart from 150 species living in freshwater, sponges are marine and found in all the oceans and at all depths from coastal waters to the deep-sea trenches at more than 8000 m depth. Most species live on hard substrates such as rock, gravel and corals. A small number are soft bottom dwellers, and they have special arrangements of long spicules to keep them from sinking into the mud, e.g., a stalk, a basal tuft, or a fringe along the lower edge of the body. Sponge aggregations in this region are principally composed of sponges from two classes: Hexactinellida and Demospongiae. They are known to occur up to water depths of at least 2500 m on soft or hard substrata. The glass sponge beds (*Vazella pourtalesi*) on the Scotian shelf are globally unique in that there are no other known aggregations of this species. In some deep-sea areas such as on Flemish Cap, sponges may represent as much as 90% of the weight of living benthic material within the community (excluding fish). Sponges show a wide range of growth rates from fast growing to very long-lived slow-growing species.

2.10.2 Ecological or biological significance

Sponge communities can support large numbers of other animals. Sponges have tiny spine-like 'spicules' within their tissues, which are made of silicon. When the animals occur in large numbers, the spicules from dead sponges form dense mats on the seabed which form a distinct habitat. Sponge habitats are known to locally enhance biodiversity (species richness and abundance) and may provide rich feeding grounds for juvenile fish.

2.10.3 Correspondence with listed habitats in other jurisdictions

OSPAR habitat : Deep-sea sponge aggregations

Habitats Directive –Annex 1: Reefs

EUNIS (European Nature Information System) habitat type code: A6.62 (May 2007): Deep-sea sponge aggregations

Biodiversity Action Plan Priority Habitats (UK): Fragile sponge & anthozoan communities on subtidal rocky habitats; Deep-sea sponge communities

NAFO Vulnerable Marine Ecosystem (for some large-sized species : *Iophon piceum*, *Stelletta* spp., *Stryphnus ponderosus*; *Axinella* sp., *Phakellia* sp. *Esperiopsis villosa*, *Geodia* spp. *Mycale lingua*, *Thenea muricata*, *Polymastia* spp., *Weberella* spp., *Asconema foliatum*, *Craniella cranium*)

ICES Sponge Grounds: *Pheronema carpenteri*, *Asconema setubalense, Vazella pourtalesi, Schaudinnia rosea, Geodia* spp., *Stryphnus ponderosus, Stelletta* spp., *Thenea* spp., *Tetilla* spp., *Polymastia* spp., *Phakellia* spp., *Mycale lingua, Antho dichotoma, Petrosia crassa, Oceanapia robusta;* VME Indicator Species: 3. Deep-sea sponge aggregations; A. Ostur sponge aggregations; B. Hard-bottom sponge gardens; C. Glass sponge communities.

FAO Annex: Examples of potentially vulnerable species groups, communities and habitats, as well as features that potentially support them- some types of sponge dominated communities

2.10.4 Further Information

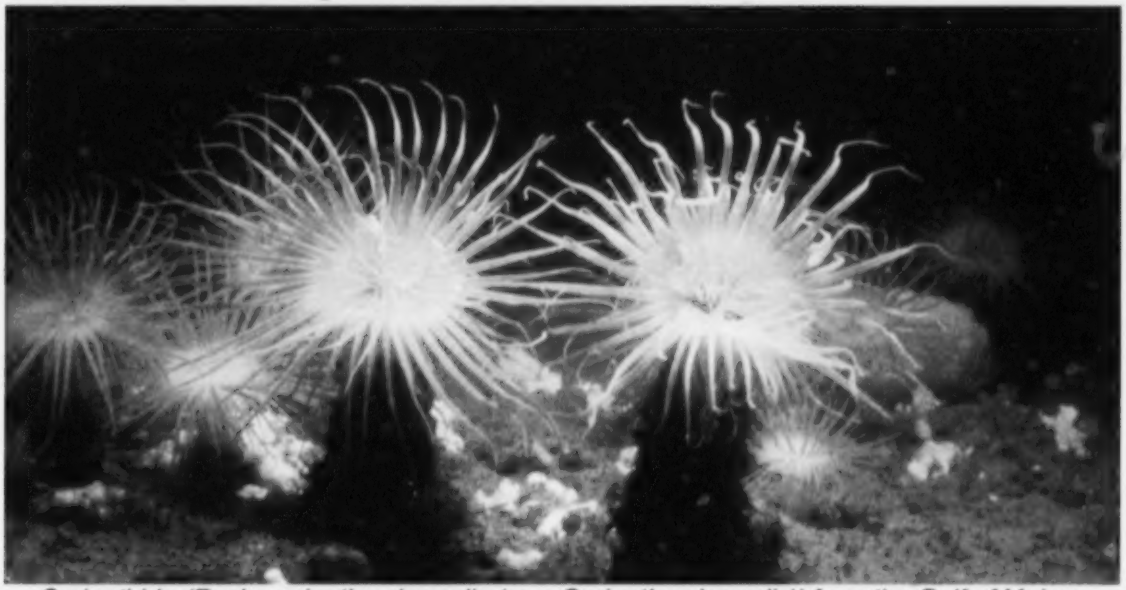
Beazley, L.I., Kenchington, E. L., Murillo, F. J. and del M. Sacau Cuadrado, M. 2013. Deep-sea sponge grounds enhance diversity and abundance of epibenthic megafauna in the Northwest Atlantic. ICES J Mar Sci. (in press online): doi:10.1093/icesjms/fst124

Fuller, S.D. 2011. Diversity of marine sponges in the Northwest Atlantic. PhD dissertation, Dalhousie University, Halifax, N.S.

Hogg, M.M., Tendal, O.S., Conway, K.W., Pomponi, S.A., van Soest, R.W.M., Gutt, J., Krautter, M. and Roberts, J.M. 2010. Deep-sea Sponge Grounds: Reservoirs of Biodiversity. UNEP-WCMC Biodiversity Series No. 32. UNEP-WCMC, Cambridge, UK.

Kenchington, E., Lirette, C., Cogswell, A., Archambault, D., Archambault, P., Benoit, H., Bernier, D., Brodie, B., Fuller, S., Gilkinson, K., Levelsque, M., Power, D., Siferd, T., Treble, M. and Wareham, V. 2010. Delineating Coral and Sponge Concentrations in the Biogeographic Regions of the East Coast of Canada Using Spatial Analyses. DFO Canadian Scientific Advisory Secretariat Research Document 2010/041. iv + 207 pp.

2.11 *Tube-Dwelling Anemone Fields*



Cerianthids *(Pachycerianthus borealis (syn. Cerianthus borealis))* from the Gulf of Maine. (http://sanctuaries.noaa.gov/pgallery/pgstellwagen/habitats/habitats_16.html)

2.11.1 Description

The order Ceriantharia includes the solitary tube-dwelling anemone-like forms with elongate bodies adapted for burrowing in soft bottoms. They can be large (over 40 cm) but most of the tube is below the sediment. Sand grains, debris and shell fragments usually stick to the outer side of the tube. Little is known about the biology of the deep-water cerianthid species. The lifespan of a similar species from Europe, *C. lloydii*, has been reported as 11 to 20 years. On the Scotian Shelf and the Gulf of Maine, the most common megafaunal tube dwelling anemone is *Pachycerianthus borealis* (syn. *Cerianthus borealis*).

2.11.2 Ecological or biological significance

Their large size and tendency to form dense aggregations, and occurrence on relatively featureless sandy or muddy bottoms, renders them key structure-forming species. Late juvenile redfish *Sebastes fasciatus*, (11-20 cm total length) have been associated with dense patches of cerianthid anemones in the Gulf of Maine. The small fish may use the cerianthid habitats on an encounter basis or they may serve as a protective corridor for moving between boulder sites. Although cerianthids can retract into their tubes, they are known to be damaged by bottom tending fishing gear. Removal of cerianthids may disrupt benthic assemblages as cerianthid predation of scallop and sabellid worm larvae has been hypothesized as an important factor in controlling their spatial distribution. The strong negative association between predator and prey is broken down by dredging disturbance.

2.11.3 Correspondence with listed habitats in other jurisdictions

OSPAR habitat : Sea-pen and burrowing megafauna communities

NAFO Vulnerable Marine Ecosystem: Tube-Dwelling Anemones (*Pachycerianthus borealis*)

ICES VME Indicator Species: 5. Tube-dwelling anemone patches

EUNIS (European Nature Information System) habitat type code: A5.441 (EUNIS Habitat Classification 2012 - a revision of the habitat classification descriptions): *Cerianthus lloydii* and other burrowing anemones in circalittoral muddy mixed sediment

Biodiversity Action Plan Priority Habitats (UK): Tide-swept Channels; Mud Habitats in Deep Water

Habitats Directive – Annex 1: Reefs and large shallow inlets and bay

2.11.4 Further Information

Fuller, S.D., Murillo Perez, F.J., Wareham, V., and Kenchington, E. 2008. Vulnerable Marine Ecosystems Dominated by Deep-Water Corals and Sponges in the NAFO Convention Area. Serial No. N5524. NAFO SCR Doc. 08/22, 24 pp.

Langton, R.W. and Robinson, W.E. 1990. Faunal associations on scallop grounds in the western Gulf of Maine. J. Exp. Mar. Biol. Ecol. 144: 157-171.

2.12 Erect Bryozoan Turf

Flustra foliacea or Lemon Weed. (Downloaded from: http://britishbryozoans.myspecies.info/category/bryozoa/bryozoa/gymnolaemata/cheilostomata/scrupariina/flustridae/flustra/flustra-foliacea-)

2.12.1 Description

Bryozoans are colonial animals (only one genus is not colonial) composed of clonal zooids which are not capable of living independently. Although most bryozoans are short-lived and studies of growth rate and colony age in large erect bryozoan species are few, some colonies can reach twenty years. Fenestrate or reteporiform cheilostomate bryozoans are some of the erect bryozoans that constitute hard structures and are popularly known as lace corals. *Flustra foliacea* or lemon weed is a common bryozoan in the Bay of Fundy that forms extensive habitat near Digby, Nova Scotia.

2.12.2 Ecological or biological significance

Erect bryozoans form ramified structures in a variety of marine environments that can be ecologically important in providing substrata for epizoans and hiding places for motile organisms, including ophiuroids and small fish. Bryozoan beds in Tasman Bay, New Zealand, provide critical habitat for juvenile snapper and tarakihi. *Flustra foliacea* or lemon weed is a common bryozoan in the Bay of Fundy. The fronds of *Flustra foliacea* host other bryozoa, hydroids, sessile polychaete worms and a variety of other invertebrates. It is also a food source for some species. Predators of marine bryozoans include nudibranchs (sea slugs), fish, sea urchins, pycnogonids, crustaceans, and starfish. Some bryozoans are considered to be invasive species.

2.12.3 Correspondence with listed habitats in other jurisdictions

EUNIS (European Nature Information System) habitat type code: A4.131 (EUNIS Habitat Classification 2012 - a revision of the habitat classification descriptions): Bryozoan turf and erect sponges on tide-swept circalittoral rock

Habitats Directive – Annex 1: Sandbanks that are slightly covered by seawater all the time; Estuaries

NAFO Vulnerable Marine Ecosystem: Erect bryozoans (*Eucratea loricata*)

ICES VME Indicator Species: 7. Bryzoan patches (*Eucratea loricata*)

Biodiversity Action Plan Priority Habitats (UK): Subtidal Sands and Gravels; Tide-swept Channels

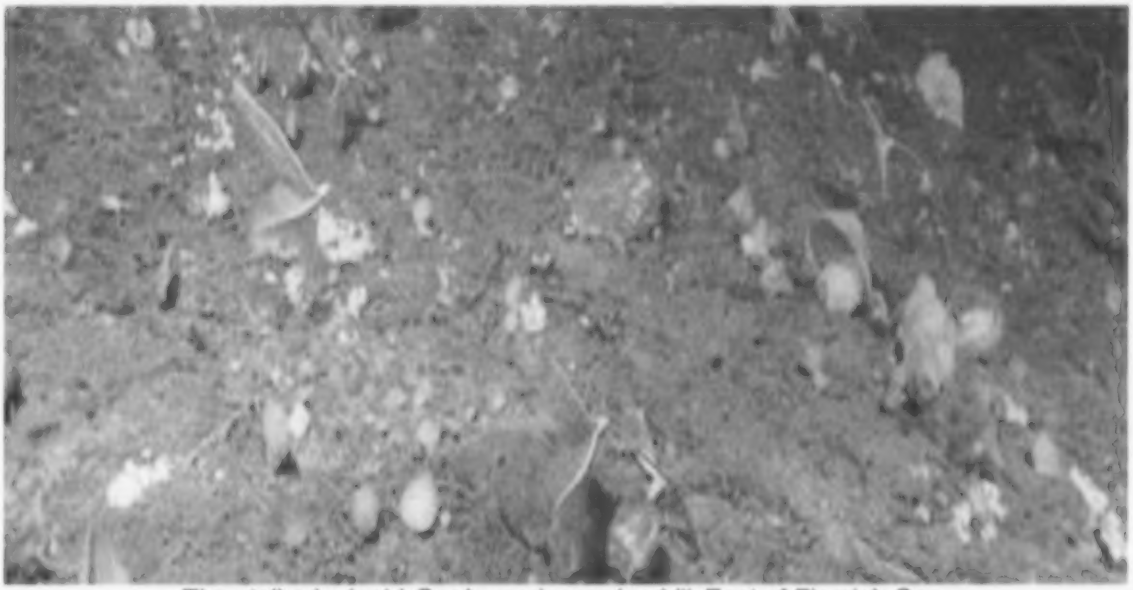
FAO Annex: Examples of potentially vulnerable species groups, communities and habitats, as well as features that potentially support them- communities composed of dense emergent fauna where large sessile protozoans (xenophyophores) and invertebrates (e.g. hydroids and bryozoans) form an important structural component of habitat

2.12.4 Further Information

Fuller, S., E. Kenchington, D. Davis and Butler, M. 1998. Associated Fauna of Commercial Scallop Grounds in the Lower Bay of Fundy. Marine Issues Committee Special Publication 2, 85 pp.

Murillo, F.J., Kenchington, E., Sacau, M., Piper, D.J.W., Wareham, V. and Munoz, A. 2011. New VME indicator species (excluding corals and sponges) and some potential VME elements of the NAFO Regulatory Area. Serial No. N6003. NAFO SCR Doc. 11/73, 20 pp.

2.13 Crinoid Beds



The stalked crinoid *Gephyrocrinus grimaldii*, East of Flemish Cap.

2.13.1 Description

Crinoids are fragile organisms that in some cases live attached to the sea bottom by a stalk that raises them off the sea floor. They are members of the echinoderm class Crinoidea and are found in all of the world's oceans to depth of 6,000 m. Stalked forms are commonly called sea lilies.

Crinoids feed by filtering small particles of food from the sea water with their feather like arms. The tube feet are covered with a sticky mucus that traps any food that floats past. Although limited information exists about their longevity or growth rates, one study estimated mean age in a population of *Endoxocrinus wyvillethomsoni* as greater than 15 yrs, with some individuals older than 20 years, and another indicated a longevity exceeding 20 yr for *Cenocrinus asterius* in 215 m depth. Some species are highly aggregated in deep water.

2.13.2 Ecological or biological significance

Some species are highly aggregated and can provide refuge and substrata for a wide variety of small fishes and invertebrates. In the Mediterranean *Leptometra phalangium* is a dominant species on the shelf break and appears to be critical habitat to juvenile and spawning benthopelagic fish. High densities of crinoids provide refuge and substrata for a wide variety of small fishes and invertebrates.

2.13.3 Correspondence with listed habitats in other jurisdictions

OSPAR habitat: Carbonate mounds

NAFO Vulnerable Marine Ecosystem: Sea Lilies (Crinoids) (*Trichometra cubensis, Conocrinus lofotensis, Gephyrocrinus grimaldii*)

ICES VME Indicator Species: 6. Mud- and sand-emergent fauna

EUNIS (European Nature Information System) habitat type code: A4.133 (EUNIS Habitat Classification 2012 - a revision of the habitat classification descriptions): Mixed turf of hydroids and large ascidians with *Swiftia pallida* and *Caryophyllia smithii* on weakly tide-swept circalittoral rock; A4.31 Brachiopod and ascidian communities on circalittoral rock

2.13.4 Further Information

Murillo, F.J., Kenchington, E., Sacau, M., Piper, D.J.W., Wareham, V. and Munoz, A. 2011. New VME indicator species (excluding corals and sponges) and some potential VME elements of the NAFO Regulatory Area. Serial No. N6003. NAFO SCR Doc. 11/73, 20 pp.

2.14 Stalked Tunicate Fields

Boltenia ovifera in the Bay of Fundy (photo credit: M. Strong, M. Buzeta).

2.14.1 Description

Tunicates or sea squirts are classified as chordates (subphylum Tunicata) as they possess dorsal nerve cords and notochords and are considered to be closely related to the immediate precursors of vertebrate forms. They are marine suspension feeders. *Boltenia ovifera*, commonly known as the "sea potato" or "sea onion", is a species of tunicate inhabiting the deep coastal waters of North America in the North Pacific and North Atlantic. The adult sea potato has a white or pinkish bulb-like body that floats in the water column and is tethered to the bottom by a stalk that terminates in a root-like holdfast or hapteron. The stalk is usually two to three times the length of the bulbous body, with the entire animal reaching 30 cm or more in length. Tunicates are hermaphroditic, with ovary and testis usually maturing at the same time. However, although eggs and sperm may be released together from the atrial siphon, self-

fertilisation is not common. Sexual reproduction results in the formation of a tadpole larva that is free-swimming for only hours before it settles on a hard substrate and begins its metamorphosis to the adult form. In the Bay of Fundy, the tadpole larvae appeared in the plankton in January and February, long before the appearance of any other plankton. *Boltenia ovifera* and other large species are often found in groups where they form significant habitat.

2.14.2 Ecological or biological significance

In the North Pacific, stalked tunicate fields are known to provide habitat to small juvenile red king crab (*Paralithodes camtschaticus*). Some sea squirts (i.e. *Boltenia ovifera*) support other invertebrate fauna attached to the stems and holdfasts. Some tunicates are considered invasive species.

2.14.3 Correspondence with listed habitats in other jurisdictions

NAFO Vulnerable Marine Ecosystem: Sea squirts (*Boltenia ovifera*)

2.14.4 Further Information

Fuller, S., E. Kenchington, D. Davis and Butler, M. 1998. Associated Fauna of Commercial Scallop Grounds in the Lower Bay of Fundy. Marine Issues Committee Special Publication 2, 85 pp.

Kenchington, E., T.J. Kenchington, L.-A. Henry, S.D. Fuller and Gonzalez, P. 2007. Multi-decadal changes in the megabenthos of the Bay of Fundy: The effects of fishing. Journal of Sea Research 58:220-240.

Lacalli, T. 1981. Annual spawning cycles and planktonic larvae of benthic invertebrates from Passamaquoddy Bay, New Brunswick. Can. J. Zool. 59:433-440.

Murillo, F.J., Kenchington, E., Sacau, M., Piper, D.J.W., Wareham, V. and Munoz, A. 2011. New VME indicator species (excluding corals and sponges) and some potential VME elements of the NAFO Regulatory Area. Serial No. N6003. NAFO SCR Doc. 11/73, 20 pp.

Trott, T.J. 2004. Cobscook Bay inventory: a historical checklist of marine invertebrates spanning 162 years. Northeastern Naturalist (Special Issue 2): 261 - 324.

3 BENTHIC BIOTURBATING SPECIES

3.1 *Xenophyophore Fields*

Xenophyophores from the Gully MPA on the Scotian Shelf. This is likely a species of *Syringammina*.

3.1.1 Description

Xenophyophores are large multinucleate single cellular organisms recently placed in the phylum Foraminifera. One species, *Syringammina fragilissima*, is among the largest known single-celled organisms reaching up to 20 centimetres in diameter. Most of them have an external test which is composed of agglutinated grains termed xenophyae. The xenophyae, which may be mineral grains, sponge spicules, foraminiferal tests or radiolarian tests, are only loosely cemented so that the test is fragile. The xenophyophores are protozoans whose protoplasm is contained largely in branched, transparent, organic tubes. The tubes, which are filled with plasma, are called granellare. The plasma includes nuclei of several different types as well as flat, rounded or spindle-shaped crystals of barium sulphate known as granellae. Part of the plasma protrudes from open ends of the tubes as branching pseudopodia which spread out over the surrounding substrate. Xenophyophores are found in the deep sea at depths greater than 500 m and are numerically dominant in canyon and slope environments and on the abyssal plain. The first Canadian record is from the Gully MPA on the Scotian Shelf. They are either suspension or surface deposit feeders and the species observed in The Gully has a large (approximately 70 mm diameter) and intricate hemispherical test of a form that has been associated with particle trapping. However, their nutrition may be more complex, possibly including the cultivation of bacteria on mucus strands. Their distribution is associated with food supply and they achieve their greatest abundance in areas of high particulate flux or deposition. The species of Xenophyophorida found in the Gully is likely *Syringammina* sp., and it was the most abundant epibenthic megafaunal taxon between 1000 and 2500 m with peak abundance between 1000 and 1500 m depth.

3.1.2 Ecological or biological significance

Xenophyophores play an important part of the benthic ecosystem through their bioturbation of the sediments, providing a habitat for other organisms. Areas dominated by xenophyophores can have 3-4 times the number of benthic crustaceans, echinoderms, and molluscs than equivalent areas that lack xenophyophores. The large amount of feces sequestered in the xenophyophore test may be sites of enhanced microbial activity. There is evidence that xenophyophores enhance deposition of organic matter and they are considered a significant source of heterogeneity on the sea floor at the scale of individual tests (cms) to large patches over 1 km in size.

3.1.3 Correspondence with listed habitats in other jurisdictions

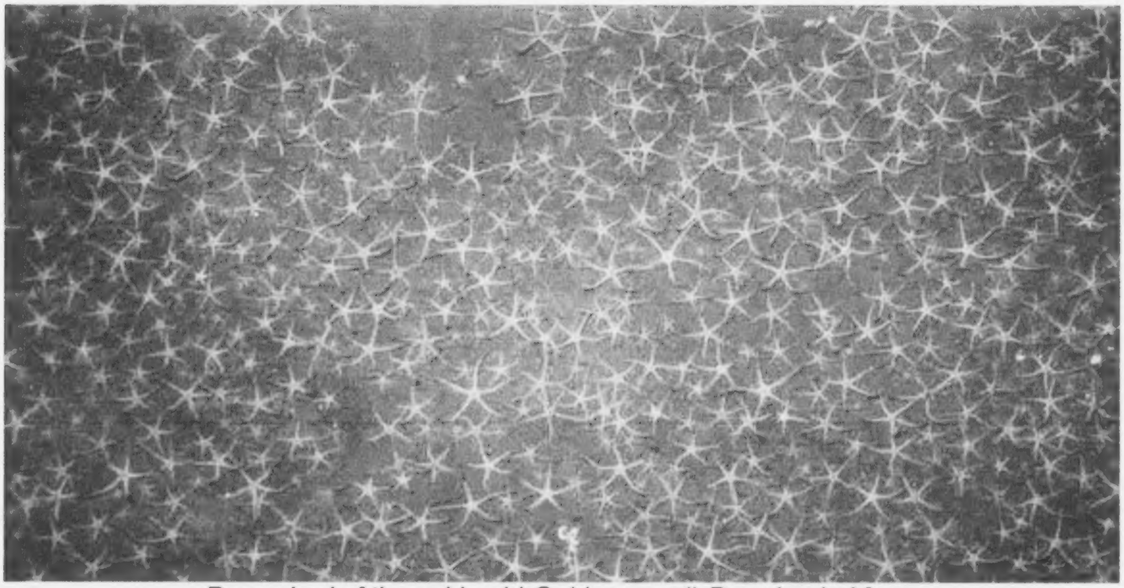
FAO Annex: Examples of potentially vulnerable species groups, communities and habitats, as well as features that potentially support them- communities composed of dense emergent fauna where large sessile protozoans (xenophyophores) and invertebrates (e.g. hydroids and bryozoans) form an important structural component of habitat

ICES Vulnerable Marine Ecosystem Indicator: 6. Mud- and sand-emergent fauna: Xenophyophora; Syringamminidae

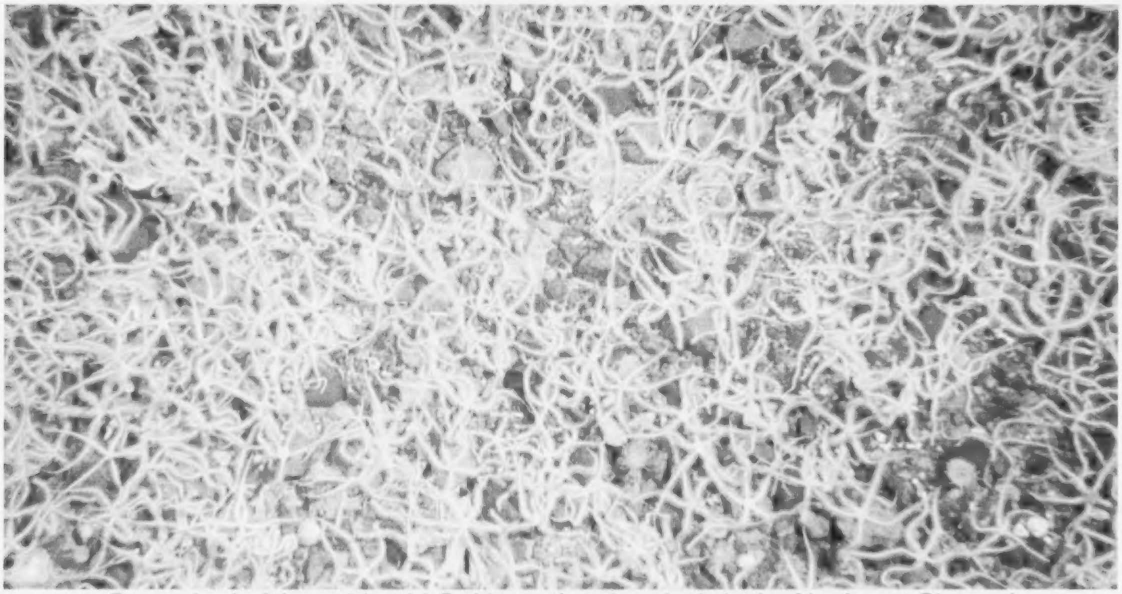
3.1.4 Further Information

Kenchington, E., Cogswell, A., MacIsaac, K., Beazley, L., Law, B. and Kenchington, T. 2013. Limited depth zonation among bathyal epibenthic megafauna of the Gully submarine canyon, northwest Atlantic. Deep Sea Research (in press online): doi:/10.1016/j.dsr2.2013.08.016

3.2 Brittle Star Beds



Dense bed of the ophiuroid *Ophiura sarsii*. Downloaded from: http://www.pinterest.com/pin/93097917270498561/


Dense bed of the ophiuroid *Ophiacantha abyssicola* in the Northeast Channel.

3.2.1 Description

Brittle stars are echinoderms in the class Ophiuroidea. Ophiuroids generally have five long slender, whip-like arms which may reach up to 60 centimetres (24 in) in length on the largest specimens. Brittle star beds vary in size, with the largest extending over hundreds of square metres of sea floor and containing millions of individuals. They usually have a patchy internal structure, with localized concentrations of higher animal density. The brittle star *Ophiura sarsii* Lütken, 1855 is common on the Scotian Shelf and widely distributed throughout the North Pacific, North Atlantic and Arctic Oceans where it occurs on soft sediments to depths of up to 2,000 m. Peak abundance appears to occur between depths of 250 and 650 m where densities greater than 300 animals/m^2 have been reported. Monospecific aggregations, or beds, are commonly observed, and the propensity for this species is to avoid individual contact, resulting in a lace-like pattern over the seabed rather than the dense intertwined aggregations formed by more gregarious species. In many parts of its distribution *O. sarsii* numerically dominates megabenthic assemblages, and dense beds are associated with low diversity of other organisms. *O. sarsii* is one of the larger members of its genus, with disc diameters attaining 25 mm and arms extending to 3 cm. A second species *Ophiacantha abyssicola* is a suspension feeding bathyal species, ranging in depth from the shelf break to about 2000m from Cape Hatteras to southern Greenland, and from the Canary Islands to northern Norway. Dense aggregations have been observed in the Northeast Channel where mean abundance at each site ranged from 390 to 1200 individuals m^2. This species is not a bioturbator but appears to be an important food source for some commercial fish species.

3.2.2 Ecological or biological significance

The ecological role of brittle stars has been examined primarily from aspects of fish predation, where they are an important food source for some flatfishes such as American plaice. Ophiurids are also known to be important ecosystem engineers, reshaping the sediment surface and influencing the distribution of other organisms. *O. sarsii* moves by means of two pairs of arms which perform a rowing action, making it an effective bioturbator of the surface sediments.

As a widespread benthic species dominant on soft bottom sediments of continental shelves, *O. sarsii* are vulnerable to impacts by bottom-tending fishing gear. Known effects on ophiurids include direct removal of organisms, physical damage, including loss of arms or crushing of the central disk, and scavenging behaviour. As ophiurids use their arms in feeding, loss of arms, although not lethal as they can regenerate, may have indirect effects on their nutrition.

3.2.3 Correspondence with listed habitats in other jurisdictions

OSPAR habitat: Sea-pen and burrowing megafauna communities

EUNIS (European Nature Information System) habitat type code: (EUNIS Habitat Classification 2012 - a revision of the habitat classification descriptions): A5.445 *Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on sublittoral mixed sediment; A3.651 *Ophiothrix fragilis* and/or *Ophiocomina nigra* brittlestar beds on slightly tide-swept circalittoral rock or mixed substrata; A4.31 Brachiopod and ascidian communities on circalittoral rock

Biodiversity Action Plan Priority Habitats (UK): Mud Habitats in Deep Water; Tide-swept Channels

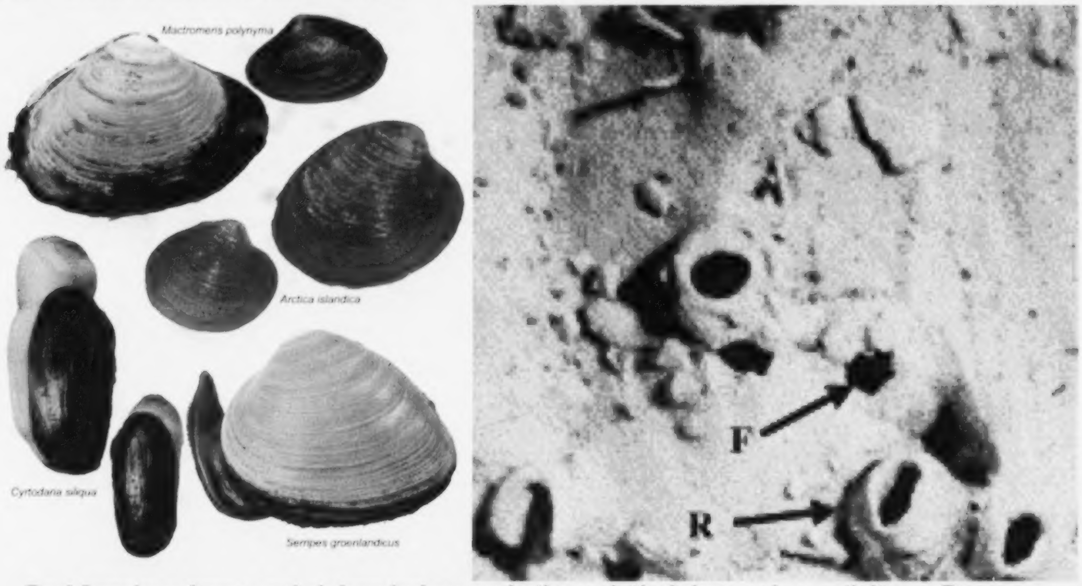
3.2.4 Further Information

Harris, J., MacIsaac, K., Gilkinson K. and Kenchington, E. 2009. Feeding biology of *Ophiura sarsi* Lütken, 1855 and the effects of fishing. Mar. Biol. 156: 1891-1902.

Metaxas, A. and Giffen, B. 2004. Dense beds of the ophiuroid *Ophiacantha abyssicola* on the continental slope off Nova Scotia, Canada. Deep Sea Res. I 51:1307-1317.

Packer, D.B., Watling, L. and Langton, R.W. 1994. The population structure of the brittle star *Ophiura sarsi* Lütken in the Gulf of Maine and its trophic relationship to American plaice (*Hippoglossoides platessoides* Fabricius). J. Exp. Mar. Biol. Ecol. 179: 207-222.

3.3 Sublittoral Clam Beds



Bed-forming clams and siphon holes made through their burrowing activity on Banquereau Bank.

3.3.1 Description

Sublittoral clam beds are common on the Scotian Shelf. There is a currently a commercial fishery for the Arctic Surfclam (*Mactromeris polynyma*) and a licence for Ocean Quahogs (*Arctica islandica*) on the Scotian Shelf. The Greenland Smoothcockles (*Serripes groenlandicus*) and Northern Propellerclams (*Cyrtodaria siliqua*) are currently caught as a by-catch in the Arctic Surfclam fishery. Some of these clams can be extremely long-lived.

The Arctic surfclam (*Mactromeris polynyma*) is a large, long lived species found mainly in coarse sand bottoms. It is a strong, active burrower, capable of burrowing several inches below the sediment surface. In the western Atlantic, they occur from the Strait of Belle Isle to Rhode Island. In the Pacific they are found from the Juan de Fuca Strait to Point Barrow Alaska, and also from Sakhalin Island, Russia. All Atlantic populations are subtidal down to 110 m, but in Alaska there are intertidal populations as well. Slow growing and long-lived, significant numbers of surfclams appear to reach forty years of age. On Banquereau, the oldest animal aged so far was 61 years old; the largest observed was 157 mm. The Alaskan population appears to be shorter lived with a maximum age of about 25 years. The inshore population in Scotia Fundy appears to be largely made up of smaller animals but there has been no extensive age sampling so far. Natural mortality (M) for the Banquereau stock, it was estimated as 0.08.

The ocean quahog (*Arctica islandica*) is one of the slowest growing and longest lived commercial species. The harvested beds off the Mid Atlantic States are dominated by animals 40 - 80 years old, with significant numbers over 100. The oldest aged specimen from the Scotian Shelf was 211, while the oldest aged anywhere is one aged from

Iceland at 405+ years. Ocean quahogs occur in eastern North America from the Arctic to Cape Hatteras, N.C. and in Europe from the Arctic to the Bay of Cadiz, Spain. It also occurs in Iceland and the British and Faroes islands. It is most abundant in fine to medium sand bottoms in depths from 4 to 260 m, deeper in the southern part of its range, and has been dredged live from as deep as 482 m. In the Scotia-Fundy Region of Nova Scotia, it is most abundant in the inshore harbours and bays of southwestern Nova Scotia, and the mouth of the Bay of Fundy. It is abundant on Sable and Western banks, and occurs in lower numbers in sandy areas throughout the region. Estimates for adult natural mortality range from 0.01 to 0.04.

3.3.2 Ecological or biological significance

The majority of the ocean floor is sedimentary, and marine sediments play a key role in the flux of nutrients and organic matter in the ocean. Via their burrowing activities, clams living in marine sediments influence oxygen levels in sediments, cause redistribution and decomposition of organic matter, disturb the natural deposited stratification, facilitate the horizontal movement of particles, restyle the micro-topography of the sediment and alter the amount of suspended particles in the water. In order to respire, feed and excrete metabolites, clams must renew their burrow water through bioirrigation. Burrowing and bioirrigation alter the sediment porosity, ph and microbial activity. Together these activities can secondarily impact benthic communities.

3.3.3 Correspondence with listed habitats in other jurisdictions

OSPAR habitat: Sea-pen and burrowing megafauna communities

EUNIS (European Nature Information System) habitat type code: (EUNIS Habitat Classification 2012 - a revision of the habitat classification descriptions): A5.237B Pontic fine and muddy sands with *Mya arenaria*; A2.312 *Hediste diversicolor* and *Macoma balthica* in littoral sandy mud; A2.243 *Hediste diversicolor*, *Macoma balthica* and *Eteone longa* in littoral muddy sand

Biodiversity Action Plan Priority Habitats (UK): Mud Habitats in Deep Water

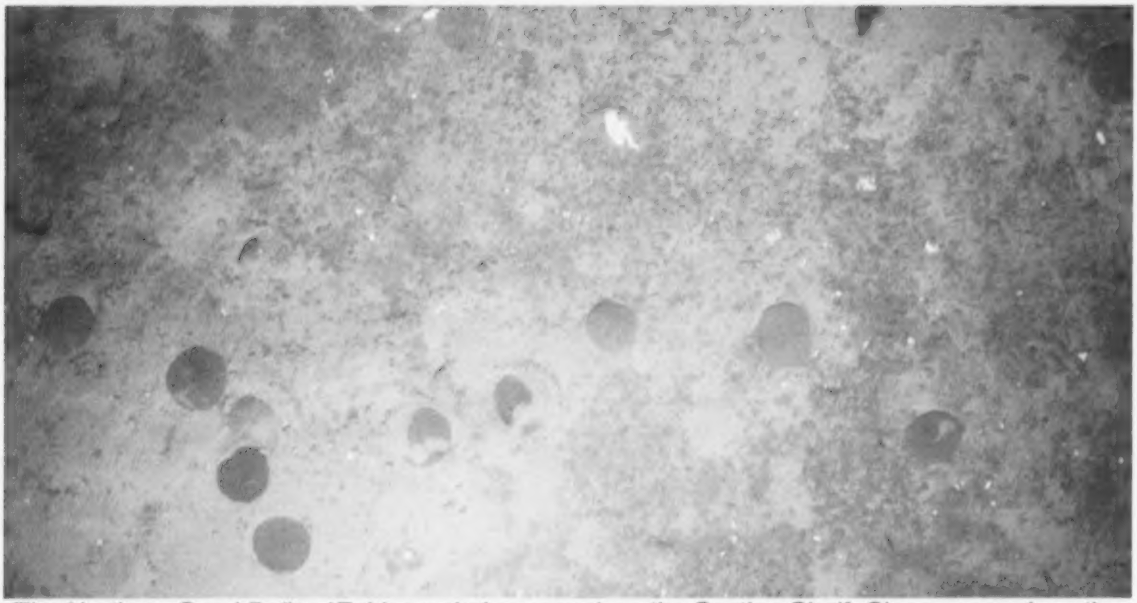
3.3.4 Further Information

DFO. 2007. Assessment of the Ocean Quahog (*Arctica islandica*) Stocks on Sable Bank and St. Mary's Bay, and the Arctic Surfclam (*Mactromeris polynyma*) Stock on Banquereau. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2007/034.

Gilkinson, K.D., Gordon, D.C. Jr., MacIsaac, K.G., McKeown, D.L., Kenchington, E.L.R., Bourbonnais, C. and Vass, W.P. 2005. Immediate Impacts and Recovery Trajectories of Macrofaunal Communities Following Hydraulic Clam Dredging on Banquereau, Eastern Canada. ICES J. Mar. Sci. 62: 925-947.

Tyrrell, M.C. 2005. Gulf of Maine Marine Habitat Primer. Gulf of Maine Council on the Marine Environment, vi+54 pp. www.gulfofmaine.org

3.4 Sand Dollar Beds



The Northern Sand Dollar (*Echinarachnius parma*) on the Scotian Shelf. Clean areas show the effects of feeding by the sand dollars on the organic floc (green material).

3.4.1 Description

Sand dollars are echinoderms belonging to the Order Clypeasteroida. The Northern Sand Dollar (*Echinarachnius parma*) is circumpolar, and can be found on the North American east coast from New Jersey north, as well as in Alaska, Siberia, British Columbia, and Japan. It is found on moderately sorted fine to medium sand bottoms with strong currents from the low intertidal to a depth of 1,500 m. A combined bottom photographic and sampling survey of Sable Island Bank revealed locally high densities (to 180 individual/m^2). *E. parma* is a heterotroph and feeds on algae and organic material found in the substrate. The spines on the somewhat flattened underside of the animal allow it to burrow or to slowly creep through the sediment. Burrowing is achieved by pushing the anterior margin of the body through the substrate at a slight angle.

3.4.2 Ecological or biological significance

Sand dollars are second in importance, after current activity, in reworking surficial sediments, and these organisms were found to modify at least a third of the total surface in a study area on Sable Island Bank. Bioturbation was particularly intense in the sector north of Sable Island. In coastal waters off Florida bioturbation by sand dollars (*Mellitta quinquiesperforata*) can limit the distribution of temperate zone seagrass (eelgrass, *Zostera marina* Lamarck) meadows through the disruption of the root-rhizome matrix. The bioturbation caused by the sand dollar *Peronella lesueuri* in the Pacific reduced the photosynthetic rate of the microphytobenthos but had a much smaller and less obvious effect on nutrient fluxes across the sediment–water interface.

3.4.3 Correspondence with listed habitats in other jurisdictions

EUNIS (European Nature Information System) habitat type code: (EUNIS Habitat Classification 2012 - a revision of the habitat classification descriptions): A5.25 Circalittoral fine sand; A5.251 *Echinocyamus pusillus*, *Ophelia borealis* and *Abra prismatica* in circalittoral fine sand

3.4.4 Further Information

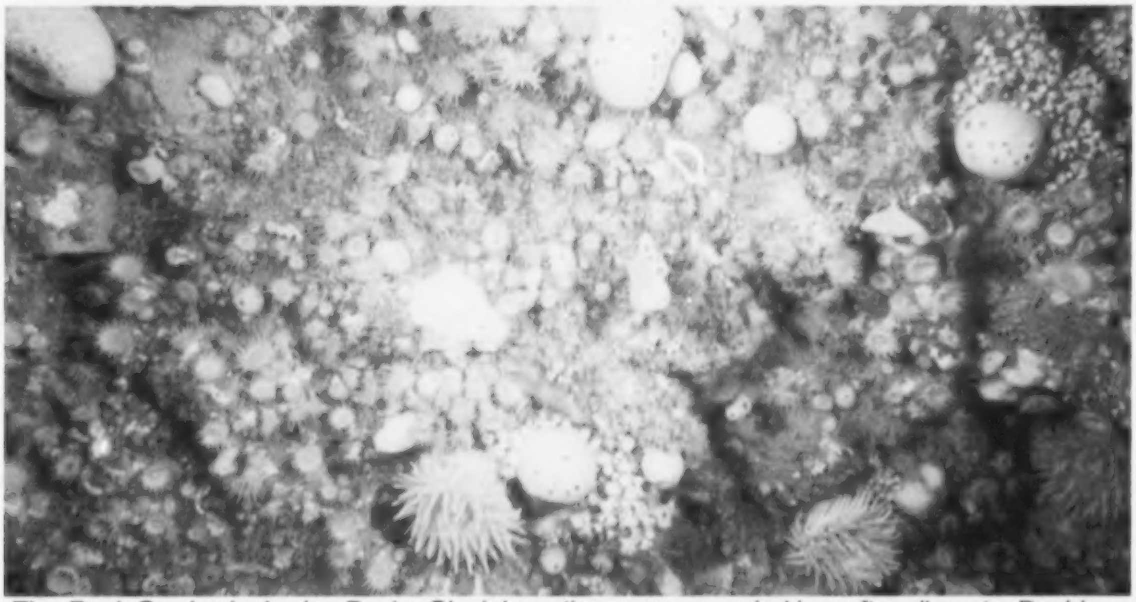
Cabanac, A., and Himmelman, J. H. 1996. Population structure of the sand dollar *Echinarachnius parma* in the subtidal zone of the northern Gulf of St. Lawrence, eastern Canada. Canadian J. Zool. 74: 698-709.

Kenchington, E.L.R., Prena, J., Gilkinson, K.D., Gordon, D.C., Jr., MacIsaac, K., Bourbonnais, C., Schwinghamer, P.J., Rowell, T.W., McKeown, D.L. and Vass, W.P. 2001. Effects of experimental otter trawling on the macrofauna of a sandy bottom ecosystem on the Grand Banks of Newfoundland. Can. J. Fish. Aquat. Sci. 58: 1043–1057.

Stanley, D. J. and James, N.P. 1971. Distribution of *Echinarachnius parma* (Lamarck) and Associated Fauna on Sable Island Bank, Southeast Canada. Smithsonian Contrib. Earth Sci. No. 6, 24 pp.

4 PHYSICAL FEATURES SUPPORTING EBSAS

4.1 Sublittoral Glacial Erratics and Morraines

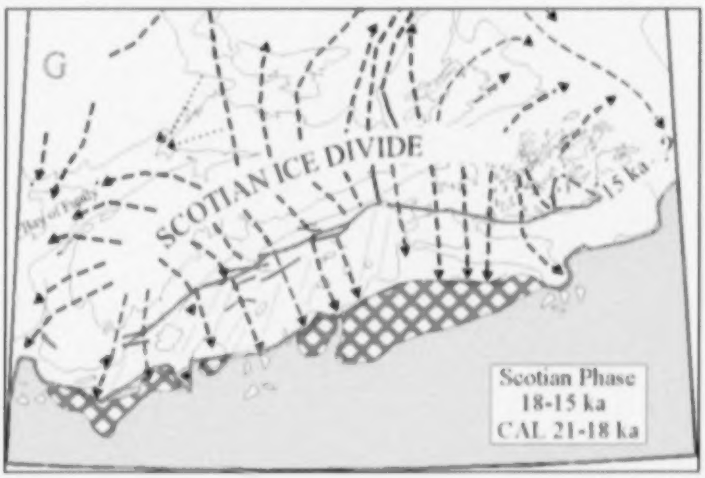


The *Rock Garden* in Jordan Basin. Glacial erratics are surrounded by soft sediments. Boulders are colonized by suite of filter feeders not found on the soft sediments.

4.1.1 Description

Erratics and morraines are glacial marine features related to the advance and retreat of ice on the continental shelf. Glacial erratics are rocks that are transported by glacial ice

over large distances and deposited in areas where they differ from the surrounding substrate. Glacial erratics are common on the Scotian Shelf and in the Gulf of Maine. North of Georges Bank, in the Gulf of Maine proper, the topographic highs have sands and larger materials including glacial erratics (boulders), while the basins are floored with muds interspersed with boulders and rocky outcrops. These islands of hard substrate locally increase habitat heterogeneity and species richness. An example is the "Rock Garden" in Jordan Basin. Glacial erratics are colonized by a diverse fauna attached to the hard substrate, locally increasing species richness. Morraines are glacial debris including rock and sediment. On the Scotian Shelf a series of retreat moraines termed the Scotian Shelf End Moraine Complex, formed by grounded glaciers with floating ice margins approximately 15.5 ka (~18.5 CAL) to 17 ka (~20 CAL). Multibeam bathymetry from northern Emerald Basin shows that the moraines occur as lobate-shaped ridges convex seaward and most are covered with iceberg furrows. Multibeam bathymetry from Browns Bank, western Scotian Shelf, shows a suite of preserved glacial features across the transgressed offshore bank. Terminal moraines are multi-lobate, up to 20 m high, and boulder covered. Other areas of the bank consist of low-relief gravel-covered terrain on which narrow and straight-curvilinear ridges occur and are interpreted as lateral moraines.



The Scotian Shelf End Moraine Complex shown as the blue lines near the Nova Scotia coastline formed sometime between approximately 15.5 ka (~18.5 CAL) to 17 ka (~20 CAL).

4.1.2 Ecological or biological significance

Glacial erratics and morraines provide hard substratum for colonization. When surrounded by soft bottom these increase habitat heterogeneity and species richness.

4.1.3 Correspondence with listed habitats in other jurisdictions

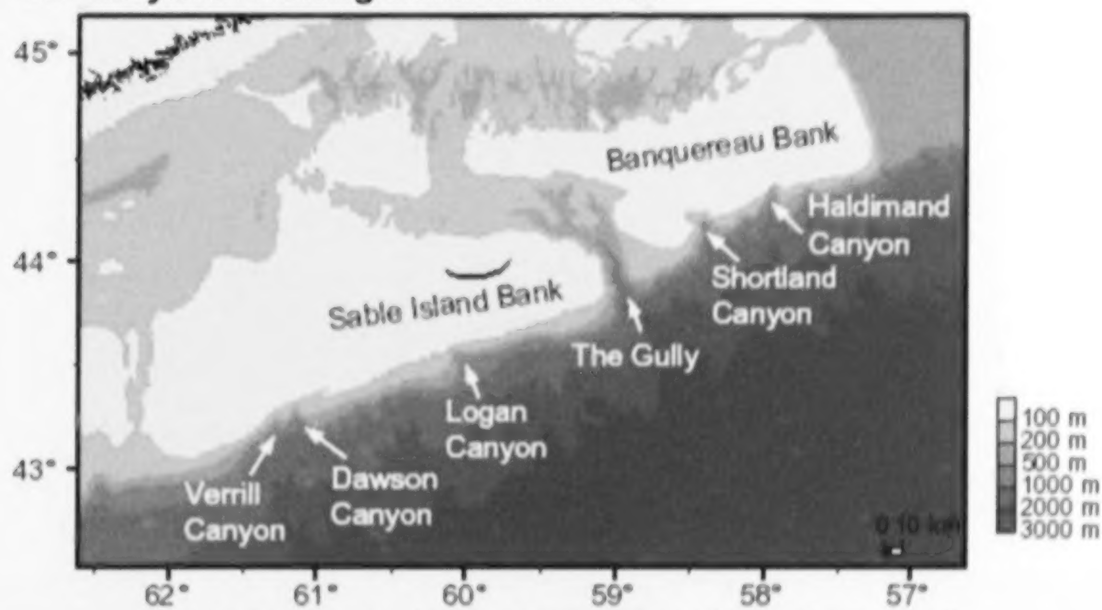
EUNIS (European Nature Information System) habitat type code: (EUNIS Habitat Classification 2012 - a revision of the habitat classification descriptions): A4 Circalittoral rock and other hard substrata

Biodiversity Action Plan Priority Habitats (UK): Subtidal Sands and Gravels

4.1.4 Further Information

Fader, G.B.J., and Todd, B.J. 2003. An interpretation of newly discovered glacial advance and retreat features from the southeast Canadian Continental Shelf based on multibeam bathymetry, geophysical surveys and seabed samples. Geoscience Horizons. 2003 Geological Society of America Annual Meeting & Exposition. November 2-5, 2003. Washington State Convention & Trade Center, Seattle, Washington.

4.2 Canyons Excising Continental Shelf



Location of some of the larger canyons excising the Scotian Shelf.

4.2.1 Description

Submarine canyons are common features along the continental margins of the world's oceans. Many are characterized by V-shaped sections with steep gradients, incised into the bedrock and sediments of continental shelves and slopes. Geologically active canyons can be important conduits of sediment and associated nutrients from the continents to the deep ocean. They generate complex water flows, channel occasional turbidity currents and focus internal tides that resuspend sediment and organic matter, which is advected to deeper water. Consequently, they can be of considerable importance to the community structure and functioning of marine ecosystems. Canyon geomorphology and local hydrodynamic conditions shape the distribution, abundance and composition of resident epibenthic megafauna by determining the depositional and erosional processes which affect surficial substrate type and heterogeneity, both of which then influence the diversity and abundance of benthic organisms. Since each canyon has unique physical characteristics, their benthic faunas can differ markedly, while being equally different from those on adjacent continental slopes. Only a fraction

of the world's submarine canyons have yet been studied and information from additional examples increases our ability to draw conclusions on the regional and global roles of canyons in marine ecosystems. The eastern continental margin of North America has a higher concentration of shelf-break canyons than many other parts of the world. One of the largest of them, The Gully, is located (near 44°N 59°W) at the edge of the Scotian Shelf east of Sable Island, where it separates Sable Island Bank from Banquereau Bank.

4.2.2 Ecological or biological significance

Submarine canyons can serve as species oases in the sea by channeling ocean currents, capturing and trapping sinking particles, funneling migrating animals, and generally providing a varied physical landscape. As a result, canyons promote high species diversity.

4.2.3 Correspondence with listed habitats in other jurisdictions

EUNIS (European Nature Information System) habitat type code: (EUNIS Habitat Classification 2012 - a revision of the habitat classification descriptions): A6.8 Deep-sea trenches and canyons, channels, slope failures and slumps on the continental slope

FAO Annex: Examples of potentially vulnerable species groups, communities and habitats, as well as features that potentially support them- canyons and trenches (e.g. burrowed clay outcrops, corals)

NAFO VME element: canyons

4.2.4 Further Information

Cogswell, A.T., Kenchington, E.L.R., Lirette, C.G., MacIsaac, K.G., Best, M.M., Beazley, L.I. and Vickers, J. 2009. The current state of knowledge concerning the distribution of coral in the Maritime Provinces. Can. Tech. Rep. Fish. Aquat. Sci. 2855: v + 66 pp.

Haedrich, R. L., Rowe, G. T., Polloni, P. T. 1980. The megabenthic fauna in the deep sea south of New England, USA. Marine Biology 57,165-179.

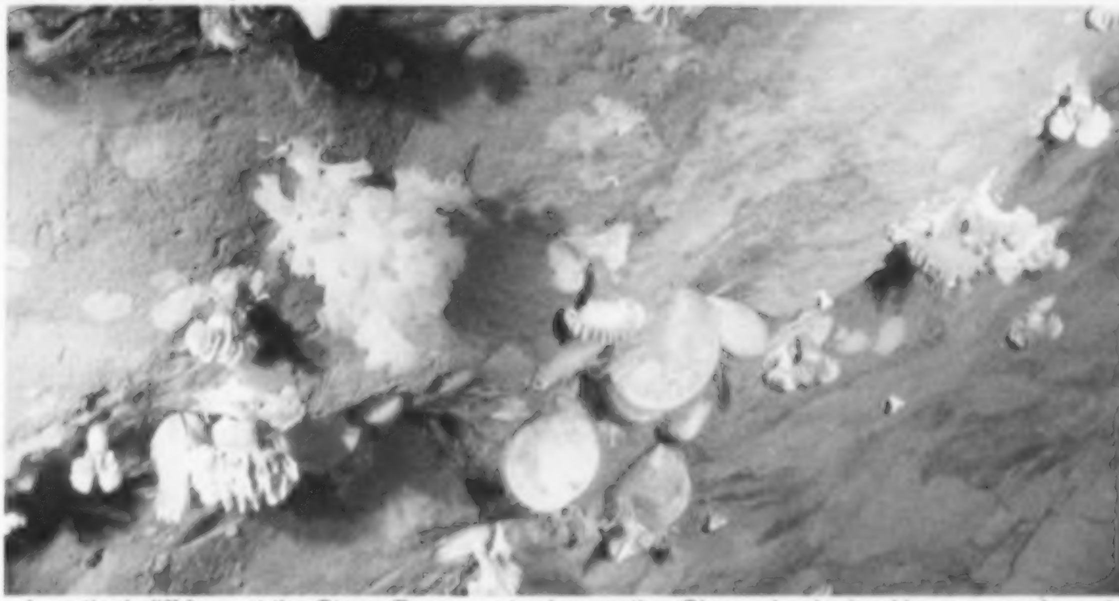
Hargrave, B.T., Kostylev, V.E., Hawkins, C.M. 2004. Benthic epifauna assemblages, biomass and respiration in The Gully region on the Scotian Shelf, NW Atlantic Ocean. Marine Ecology Progress Series 270, 55-70.

Harris, P.T., Whiteway, T. 2011. Global distribution of large submarine canyons: Geomorphic differences between active and passive continental margins. Marine Geology 285, 69-86.

Hecker, B., 1990. Variation in megafaunal assemblages on the continental margin south of New England. Deep Sea Res. 37, 37–57.

Murillo, F.J., Kenchington, E., Sacau, M., Piper, D.J.W., Wareham, V. and Munoz, A. 2011. New VME indicator species (excluding corals and sponges) and some potential VME elements of the NAFO Regulatory Area. Serial No. N6003. NAFO SCR Doc. 11/73, 20 pp.

4.3 Steep Slopes (Cliffs)



A vertical cliff face at the Stone Fence, outer Laurentian Channel colonized by cup corals and file shells.

4.3.1 Description

Vertical rock faces are defined as at an angle of 70° or greater.

4.3.2 Ecological or biological significance

These underwater cliffs support solitary cup corals (*Desmophyllum* spp.), file shells (*Acesta* sp.), large gorgonian corals (e.g., *Paragorgia arborea*, *Paragorgia johnsonii*, *Primnoa resaedeformis*), sponges and other invertebrates.

4.3.3 Correspondence with listed habitats in other jurisdictions

EUNIS (European Nature Information System) habitat type code: (EUNIS Habitat Classification 2012 - a revision of the habitat classification descriptions): A6.8 Deep-sea trenches and canyons, channels, slope failures and slumps on the continental slope

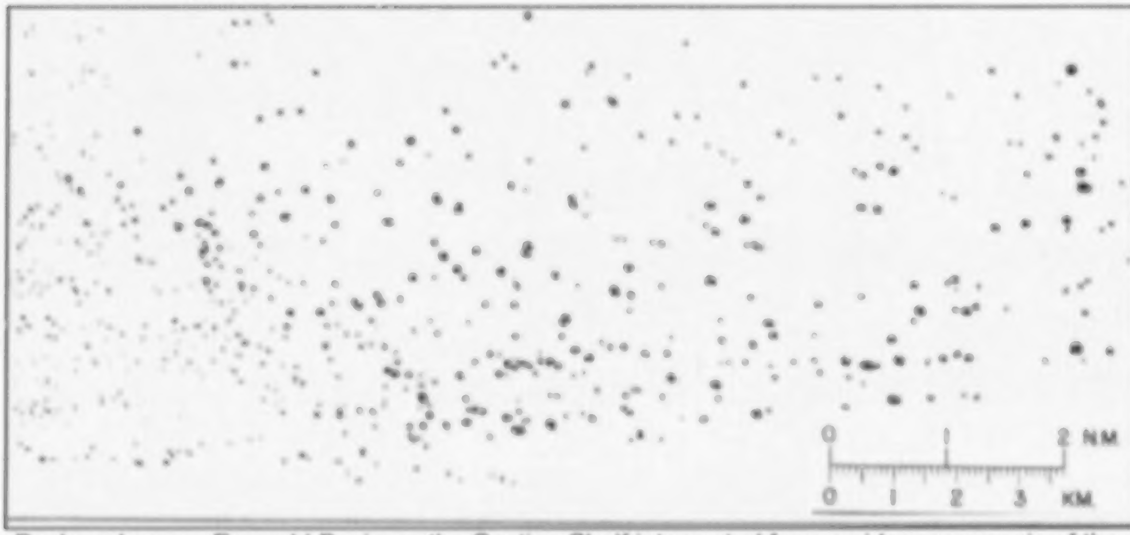
FAO Annex: Examples of potentially vulnerable species groups, communities and habitats, as well as features that potentially support them- submerged edges and slopes (e.g. corals and sponges)

NAFO VME element: steep slopes

4.3.4 Further Information

Murillo, F.J., Kenchington, E., Sacau, M., Piper, D.J.W., Wareham, V. and Munoz, A. 2011. New VME indicator species (excluding corals and sponges) and some potential VME elements of the NAFO Regulatory Area. Serial No. N6003. NAFO SCR Doc. 11/73, 20 pp.

4.4 Pockmarks



Pockmarks near Emerald Basin on the Scotian Shelf interpreted from a sidescan mosaic of the area.

4.4.1 Description

Pockmarks are craters in the seabed caused by fluids (gas and liquids) erupting and streaming through the sediments. Since the discovery of pockmarks on the ocean floor in 1970 off the coast of Nova Scotia, pockmarks have been found to exist in all of the world's oceans. The craters off Nova Scotia are up to 150 m in diameter and 10 m deep and are formed in seabed material consisting of soft silty clay (LaHave clay). The detailed mechanism of formation and the origin of the gas in the sediments is still unknown.

4.4.2 Ecological or biological significance

Geochemical measurements of cores of ~100 cm depth of pockmarks in Passamaquoddy Bay, Bay of Fundy suggested that sedimentary microbial metabolism was different inside than outside pockmarks. The megabiota consisted of the sea star *Asterias rubens*, commonest outside pockmarks; the sea cucumber *Cucumaria frondosa*, commonest on pockmark bottoms; an unidentified bryozoan/hydrozoan and the filamentous bacterium *Beggiatoa* sp., commonest on pockmark sidewalls.

4.4.3 Correspondence with listed habitats in other jurisdictions

FAO Annex: Examples of potentially vulnerable species groups, communities and habitats, as well as features that potentially support them- cold seeps (e.g. mud volcanoes for microbes, hard substrates for sessile invertebrates).

EUNIS (European Nature Information System) habitat type code: (EUNIS Habitat Classification 2012 - a revision of the habitat classification descriptions): A6.9111 Cold seep benthic communities of hadal zone; NATURA 2000 habitat type code 1180 Submarine structures made by leaking gases (Black Sea Marine Habitat Classification Workshop, May 2007)

4.4.4 Further Information

Hovland, M. and Judd, A.G. 1988. Seabed pockmarks and seepages—impacts on geology, biology and the marine environment. Graham and Trotman, London, 293pp.

Josenhans, H.W., King, L.H. and Fader, G. B. 1978. A side-scan sonar mosaic of pockmarks on the Scotian Shelf. Can. J. Earth Sci. 15: 831-840.

King, L.H. and MacLean, B. 1970. Pockmarks on the Scotian Shelf. Geological Society of America Bulletin 81, 3141-3148.

Wildish, D.J., Akagi, H.M., McKeown, D.L., and Pohle, G.W. 2008. Pockmarks influence benthic communities in Passamaquoddy Bay, Bay of Fundy, Canada. Mar. Ecol. Prog. Ser. 357:51-66.

5 ACKNOWLEDGEMENTS

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